

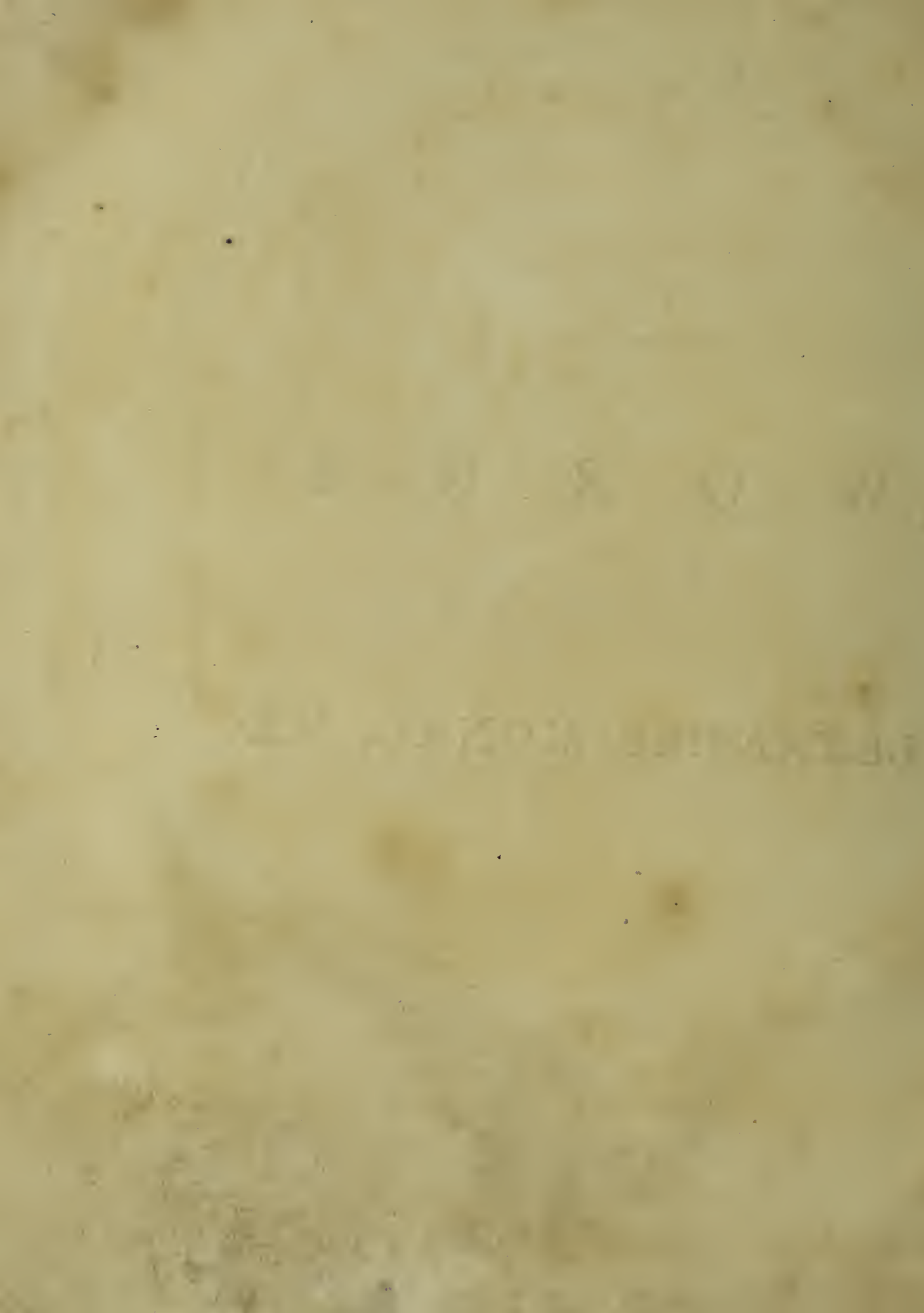


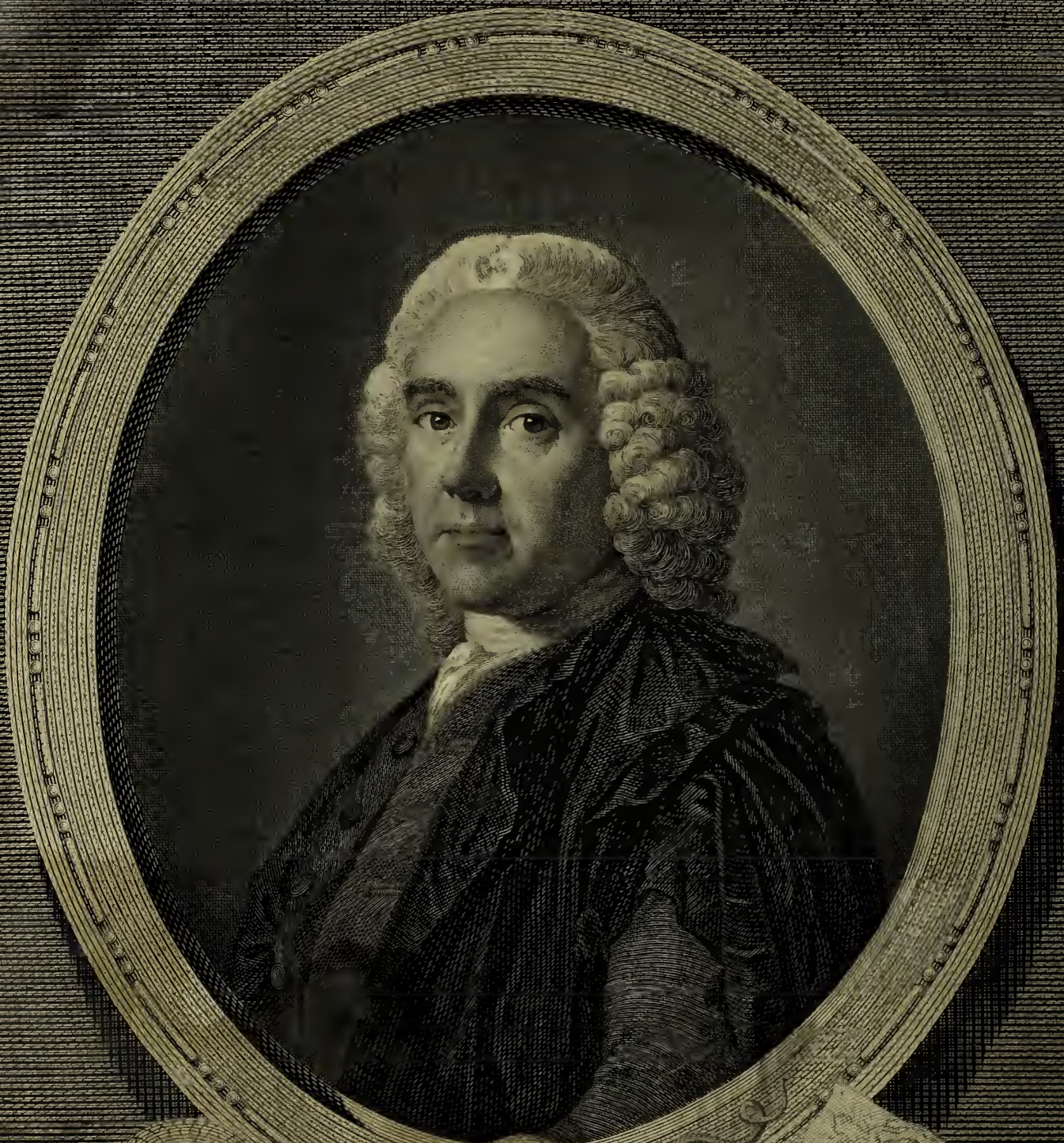
T H E

W O R K S

O F

ALEXANDER MONRO, M.D.





ALEXANDER MONRO SEN.^R M.D.

Professor of Anatomy, Fellow of the Royal College of Physicians at Edinburgh, and F.R.S.

Painted by Allan Ramsay Esq.

Engraved by James Duffie 1776.

T H E
W O R K S
O F

ALEXANDER MONRO, M.D.

FELLOW of the ROYAL SOCIETY,

FELLOW of the ROYAL COLLEGE of PHYSICIANS,

AND LATE

PROFESSOR of MEDICINE and ANATOMY in the UNIVERSITY
of EDINBURGH.

PUBLISHED BY HIS SON,

ALEXANDER MONRO, M.D.

PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS, AND PROFESSOR OF MEDICINE
AND OF ANATOMY AND SURGERY IN THE UNIVERSITY OF EDINBURGH.

TO WHICH IS PREFIXED,

The LIFE of the AUTHOR.

ILLUSTRATED WITH COPPERPLATES.

EDINBURGH:

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THE HISTORY OF THE

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ADVERTISEMENT by the EDITOR.

I FLATTER myself, that this Collection of the Works of my Father, properly arranged, will prove not only acceptable to his Pupils and Friends, but useful to the Public, as many of them treat expressly of Practical Subjects, and that in all some application to Practice is pointed out.

To the Works printed under his own inspection, I have added two Pieces.

The first is an Oration DE CUTICULA HUMANA, delivered by him above forty years ago in the Common Hall of this University; in which many curious circumstances are described which had escaped the observation of former Anatomists, particularly the appearance of the Fibres that connect the Cuticula to the Cutis Vera, which since that time has been annually demonstrated in the Anatomical Theatre of this Place.

The other Piece is an ESSAY ON COMPARATIVE ANATOMY, composed from notes taken at his Lectures, and published at London in 1744.

But as this ESSAY was published without his consent or knowledge, and that of course many errors had crept into it; I have endeavoured to correct these, and made a few additions to it, from observations collected by himself with a view to a larger work on that subject; but which, by various avocations, he was prevented from prosecuting.

To the whole are prefixed an Engraving, executed by Mr BASIRE, from an excellent Portrait of my Father by ALLAN RAMSAY, Esq; and an Account of his Life, composed by my brother Dr DONALD physician at London.

EDIN. Feb. 5. }
1781. }

ALEXANDER MONRO.

THE HISTORY OF THE

PROGRESS OF THE
ART OF PRINTING IN
ENGLAND

FROM THE FIRST BEGINNINGS TO THE PRESENT TIME

IN TWO VOLUMES
THE FIRST VOLUME
CONTAINING THE HISTORY OF THE
ART OF PRINTING IN
ENGLAND FROM THE FIRST BEGINNINGS TO THE PRESENT TIME

BY
JOHN WELLS

IN TWO VOLUMES
THE SECOND VOLUME
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THE

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A C C O U N T
O F T H E
L I F E O F T H E A U T H O R.

THE AUTHOR of the following sheets, the late Dr ALEXANDER MONRO, physician, and professor of medicine and of anatomy in the university of Edinburgh, was descended by his father from the family of Monro of Milton, which formerly had large possessions in the county of Ross; and by his mother, from that of Forbes of Culloden.

His grandfather Sir Alexander Monro of Bearcrofts, and grand-uncle David, were both Colonels in the army of king Charles at the battle of Worcester, where David was killed. After the Restoration, Sir Alexander quitted the profession of arms, and studied the law; and soon after being admitted an advocate, was appointed one of the principal clerks of the court of Session. He left two sons behind him. George, the eldest, having entered into the army, arrived at the rank of Major; and after quitting the service, retired to live at Auchinbowie, a feat he had in the county of Stirling.

The younger son, John, the father of our Author, was bred to physic and surgery. After having finished his studies, he served for some years as a surgeon in the army under King William in Flanders. Before his appointment in the army, he had married his cousin Miss Forbes, niece to Mr Forbes of Culloden; and for some years successively obtained leave of absence from the army in the winter, and resided with his wife in London, where his son Alexander was born on the 8th of September O. S. 1697.

About three years thereafter, he quitted the army, and went to settle

as a surgeon at Edinburgh, where his knowledge in his profession and engaging manners soon introduced him into an extensive practice. Perceiving early marks of superior talents in his son (an only child), he paid the greatest attention to his education, and it became the object from which he ever derived his greatest felicity.

The son shewed an early inclination to the study of physic; and the father, after giving him the best education that Edinburgh then afforded, sent him successively to London, Paris, and Leyden, to improve himself further in his profession.

At London, he attended the lectures of Messrs Hawksbee and Whiston on experimental philosophy, and the anatomical demonstrations of Mr Cheselden. He at the same time employed himself much in dissection; and having been admitted a member of a society of young physicians and surgeons, who by rotation read discourses on the uses of the different organs, he read to them the first sketch of his general account of the bones, which has been since published. From the bodies he dissected he made a great many anatomical preparations, which he sent home to his father; who, after shewing them to the college of physicians, gave them to be deposited in the cabinet of curiosities which was then kept at surgeon's hall; and Mr Adam Drummond, who was nominal professor and demonstrator of anatomy to the surgeons company, was so well pleased with them, that he desired his father to write to our young student, that if he continued to improve himself in the study of anatomy as he had begun, he would resign in his favour so soon as he should return to Edinburgh.

From London he went to Paris, where he attended the hospitals, and the lectures which were read on the different branches of physic and surgery at that time.

Towards the end of autumn 1718, he went to Leyden, and studied under the great Boerhaave; to whom he became particularly known, by having a great number of cases sent to him from Scotland to consult him upon. Boerhaave soon conceived a high opinion of the quickness of his parts and of his knowledge in his profession, and wrote a very favourable opinion of him to his friends. And, from manuscripts which still remain, it appears that he was very assiduous, and gave great application to his studies wherever he went.

On his return to Edinburgh, in autumn 1719, Messrs Drummond and Macgill, who were then conjunct nominal professors and demonstrators of anatomy to the surgeons company, offering to resign in his favour, he found himself under the necessity of entering a member with them.

Soon after his appointment, his father prevailed on him to read some public lectures on anatomy, and to illustrate them by shewing the anatomical preparations which he had made and sent home when abroad; and, without his knowledge, invited the president and fellows of the college of physicians, and the whole company of surgeons, to honour the first day's lecture with their presence. This unexpected company threw him into such confusion as to make him entirely forget the words of the discourse he had written and committed to memory. Having left his papers at home, he was at a loss for some little time what to do: but having a ready presence of mind, he immediately began to shew some of the anatomical preparations, in order to gain a little time for recollection; and very soon resolved not to attempt to repeat the discourse he had written, but to express himself in such words as should occur to him from the subject, which he was confident he understood. The experiment succeeded; he delivered himself well, and gained great applause as a good and ready speaker. After this, being persuaded that words expressive of his meaning would always occur in speaking on a subject which he understood, he never during his whole lifetime attempted, in teaching, to repeat the words of any written discourse; but spoke from memory, and expressed himself easily, and even elegantly, in such words as flowed from the subject.

At the same time, his father persuaded Dr Alston professor of botany and materia medica *, then a young man, to give some public lectures on botany.

In the beginning of the winter 1720, these two young professors, Dr Alston and Dr Monro, began to give regular courses of lectures, the one on the Materia Medica and Botany, the other on Anatomy and Surgery; which were the first regular courses of lectures on any of the branches of medicine that had ever been read at Edinburgh, and may be looked up-

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on

* Many years before this period there was a professor of botany belonging to the university, but none of Dr Alston's predecessors had given regular courses of lectures.

on as the opening of that medical school which has since acquired such great reputation all over Europe.

In summer 1721 and 1722, Dr MONRO, by the persuasion of his father, read some lectures on chirurgical subjects; particularly on wounds and tumours, which he never would publish, having wrote them in a hurry and before he had much experience; but inserted from time to time the improvements he thought might be made in surgery, in the volumes of *Medical Essays and Observations*, of which some account will be given hereafter.

About the year 1720, his father communicated to the physicians and surgeons at Edinburgh, a plan, which he had long formed in his own mind, of having the different branches of physic and surgery regularly taught at Edinburgh, which was highly approved of by them; and by their interest regular professorships of anatomy and medicine were instituted in the university.

His son, Dr MONRO, was first made university-professor of Anatomy; and two or three years afterwards, Drs Sinclair, Rutherford, Innes, and Plummer, were made professors of Medicine; the professorship of *Materia Medica* and Botany, which Dr Alston then held, having been added to the university many years before.

Immediately after these gentlemen were elected Professors, they began to deliver regular courses of lectures on the different branches of medicine, and they and their successors have uniformly continued so to do every winter.

The plan for a medical education at Edinburgh was still incomplete without an hospital, where students could see the practice of physic and surgery, as well as hear the lectures of the professors. A scheme was therefore proposed by Dr Monro's father, and others, particularly the Members of the Royal College of Physicians and Board of Surgeons, for raising by subscription a fund for building and supporting an hospital for the reception of diseased poor, and our Author published a pamphlet setting forth the advantages that would attend such an institution. In a short time a considerable sum of money was raised, a small house was fitted up, and patients were admitted into it, and regularly attended by many of the physicians and surgeons * in town.

Some

* For several years the medicines for the sick in the hospital were furnished gratis by the surgeon-apothecaries in town.

Some years after this, a plan of a new hospital capable of holding near 300 patients, with every sort of convenience for them, was drawn out by the late Mr Adams, architect, under the inspection of the managers, and particularly of our Author, who planned the operation-room and some other principal parts. A patent was obtained from the Crown, forming the contributors to the charity into a corporation, with the power of nominating eleven managers besides the professor of anatomy, who by the charter is to be officially one, and making rules for the election of their successors. Soon after, that very worthy and most excellent citizen the late George Drummond, Esq; one of the Commissioners of Excise, who had often served the office of First Magistrate (Lord Provost) of the city of Edinburgh, and who was one of the most active and assiduous promoters of this most useful undertaking, together with our Author, were unanimously appointed by the first contributors to superintend the building of the present elegant and most useful hospital, under the name of the *Building Committee*.

After the first stone was laid, so great was the zeal and public spirit of all ranks of people † for promoting this excellent charity, that the building was completed in a much shorter time than the most sanguine expectations could have imagined: And it has since been so largely endowed, as to be capable of receiving a great number of diseased poor, whose cases the students of physic and surgery have an opportunity of seeing daily treated with the greatest attention and care by physicians and surgeons eminent in their profession; and a register of the particulars
of

† Dr Moore, in his account of Travels through Scotland, mentions this hospital. He says, "They have likewise an infirmary at Edinburgh, which is a good building: it is well-founded, and very convenient both for the patients and the chirurgical operations. The building was erected by the inhabitants, and they undertook it with great spirit: the proprietors of many stone-quarries made presents of stone; others of lime; merchants contributed timber; carpenters and masons were not wanting in their contributions; the neighbouring farmers agreed to carry the materials gratis; the journeymen-masons contributed their labours for a certain quantity of hewn stones; and as this undertaking is for the relief of the diseased, lame, and maimed poor, even the day-labourers could not be exempted, but agreed to work a day in the month gratis towards the erection. The ladies contributed in their way to it; for they appointed an assembly for the benefit of the work, which was well attended, and every one contributed bountifully." See Mr Hamilton Moore's *Collection of Voyages and Travels*, p. 1064.

of all the cases which have been received into the house since its first opening has been kept, in books appropriated for that purpose, for the use of the students.

In order to make the hospital of still further use to the students, Dr MONRO frequently, while he continued professor of anatomy, gave lectures on the surgical cases; and the late judicious physician, Dr Rutherford, professor of the practice of physic, began in the year 1748 to deliver clinical lectures, to be continued every winter, on the most remarkable cases in the hospital; and his example was afterwards followed by our Author after he had resigned the anatomical chair to his son, and by Doctors Cullen, Whyte, Home, and Gregory senior and junior.

Doctor MONRO, though he was elected Professor of Anatomy in the year 1721, was not received into the University till the year 1725, when he was inducted along with that great mathematician the late Mr Colin Maclaurin, with whom he ever lived in the strictest friendship.

From the time of his being received into the University, till the time of his resigning in favour of his son the present Dr Alexander, he regularly every winter gave a course of lectures on anatomy and surgery, which lasted from October to May, digested under the following heads.

1. He began with giving a History of Anatomy: in delivering of which he shewed a strength of memory, and facility of speaking, beyond most men; for he gave a regular account of the most remarkable anatomists from the earliest to the present times, mentioning their different improvements and discoveries, the dates of the times in which they were made, and the different claims of authors to the honour of particular discoveries, without ever being at a loss for words, or using any other notes than the names of the anatomists, with the times in which they had lived.

2. He entered on the Osteology; and after giving some lectures on the structure, uses, and diseases, of the bones in general, he entered into the consideration of the particular bones; each of which he shewed to the students, both singly and in the skeleton; and after demonstrating its particular parts and structure, he treated of its uses, and the diseases and accidents to which it was liable.

3, 4. He

3, 4. He demonstrated, on adult subjects, the Muscles, the Abdominal and Thoracic Viscera, and Brain; and shewed the Nerves and Blood-vessels in the dead bodies of children: and after demonstrating each organ, he always treated particularly of its structure and diseases, and shewed preparations of the different parts as he treated of them.

5. He illustrated the anatomy of the human body by the dissection of different animals, Quadrupeds, Fowls, and Fishes, and by comparing the structure and uses of their organs with those of the human body.

6. He considered particularly the Diseases for which chîrurgical operations were commonly undertaken, and the best methods of treating them; and then shewed to his pupils the different Operations of Surgery performed on dead human bodies, and mentioned the various methods which had been proposed for performing them, with the advantages and disadvantages attending each.

7. After the operations of surgery, he shewed the different Bandages and Machines used in surgery, and the manner of applying them; and mentioned particularly the cases in which they were useful.

8. He concluded his winter-course with some general lectures on the Physiology of the human body.

He continued with the greatest assiduity, and without the least interruption, to give such a course every winter for near forty years; and so great was the reputation he had acquired, that students flocked to him from the most distant corners of his Majesty's dominions.

After he resigned the anatomical chair to his son, he still endeavoured to render his labours useful to mankind, by reading clinical lectures at the hospital for the improvement of the students; of which Dr Duncan, who was one of his pupils, has given the following account. " There I
 " had myself the happiness of being a pupil, who profited by the judi-
 " cious conduct of his practice, and was improved by the wisdom and
 " acuteness of his remarks. I have indeed to regret that I attended only
 " the last course of his lectures in which he had ever a share, and at a
 " time when he was subjected to a disease which proved at length fatal.
 " Still, however, from what I saw and from what I heard, I can venture
 " to assert, that it is hardly possible to conceive a physician more atten-
 " tive

“ tive to practice, or a preceptor more anxious to communicate instructions. His humanity, in the former of these characters, led him to bestow the most anxious care on his patients while they were alive ; and his zeal in the latter induced him to make them the subject of useful lessons when they happened to die.

“ In the different stations of physician, of lecturer, and of manager in the hospital, he took every measure for inquiring into the causes of diseases by dissection. He personally attended the opening of every body ; and he not only dictated to the students an accurate report of the dissection, but with nice discrimination contrasted the diseased and sound state of every organ. Thus in his own person, he afforded to the students a conspicuous example of the advantages of early anatomical pursuits, as the happiest foundation for a medical superstructure. His being at once engaged in two departments, the Anatomical Theatre and Clinical Chair, furnished him with opportunities both on the dead and living body, and placed him in the most favourable situation for the improvement of medicine, and from these opportunities he derived every possible advantage which they could afford.”

Of the Works of our Author, the first and greatest is his *Osteology*, or Treatise on the Anatomy of the Bones ; which was originally published in the year 1726, for the use of the students who attended his lectures. In this performance he has not confined himself to a mere description of the bones, but has added many practical observations and corollaries. It met with such a favourable reception, that it underwent eight different editions during his lifetime, and was translated into most of the European languages ; and the French edition in large folio, published by Monsieur Sue, demonstrator to the Royal Academy of Sculpture and Painting at Paris, is adorned with as elegant and masterly engravings of the figures of the bones as are to be found in any anatomical work.

To the later editions of his *Osteology* he annexed a *Neurology* *, or Anatomy of the Human Nerves, in which he describes concisely the larger branches of the particular nerves ; avoiding the description of the very minute branches, as being apt to confound young students, for whose

* This Treatise on the Nerves has not only been translated along with the *Osteology* into several living languages ; but has been also translated into Latin by itself with notes, by Dr Coopmans of Franeker in Holland.

whose improvement he wrote. In this treatise he has also mentioned most of the prevailing opinions concerning their structure and use; and endeavoured to account for many symptoms observed in diseases from their sympathy and mutual connexions. He subjoined to this work, a more accurate description of the Receptacle of the Chyle, and Thoracic Duct, than is to be found in most systems of Anatomy.

Soon after the establishment of the hospital, the professors of medicine and many other physicians and surgeons in town formed themselves into a Society for collecting and publishing such medical observations and essays as should occur to them, or be sent to them by their friends, and they appointed Dr MONRO to be their Secretary.—For the first year the members attended the meetings of the Society, and revised and made remarks on the papers presented to them: but after the publication of the first volume in the year 1732, they grew remiss in their attendance, and very soon the whole care of the collection fell upon the Secretary; in so much that, after this, scarce any other member ever saw a paper of the five last volumes, except those they were the authors of, till printed copies were sent them by the bookseller.

In the papers of that collection wrote by our Author, and republished in the present Volume, he has made many material improvements on the descriptions before given of the structure and uses of several parts of the body; drawn many useful practical corollaries from anatomy; and proposed many new improvements in the method of performing surgical operations, most of which are now adopted in the practice and writings of our more modern surgeons.

The six volumes of Medical Essays and Observations which contain these papers have been so much approved of, as to have undergone various editions in the English language, and to have been translated into many foreign languages; and the late celebrated Dr Haller had such a high opinion of them, as to say, they were books which no medical man ought to be without*.

After the publication of the above-mentioned six volumes, the late Mr Maclaurin Professor of Mathematics proposed to enlarge the plan of the

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Society.

* “*Quinque Volumina Speciminum Societatis Edinburgensis prodierunt, (quorum ultimum duplex est), Medicis perutilia et Chirurgis et Anatomicis. MONROUS ibi eminet.*” *Haller Meth. Stud. Med.* p. 69.

Society, by admitting Gentlemen eminent in literary and philosophical learning, and receiving philosophical as well as medical papers. This proposal was approved of: but after this new Society was formed, and several papers read, their meetings were interrupted for some years; first by the Rebellion breaking out in the year 1745; and afterwards by the death of Mr Maclaurin, which happened soon after. At last they were renewed, principally by the activity of our Author, who was then elected one of their Vice-Presidents; and before his death two volumes were published, and some materials for a third collected. In the two first volumes, we find several papers written by our Author, which contain many useful remarks and observations: These also are reprinted in the present Collection.

His last publication was his *Account of the Success of Inoculation in Scotland*; which was originally written in answer to a letter sent him by the Delegates of the Faculty of Physicians at Paris appointed to examine into the merits of that practice. It was afterwards published at the desire of some of his friends, and had a good effect in rendering this very useful practice more universal than it had formerly been in Scotland.

Besides the works which he published, he left several Manuscripts, wrote at different times, on different anatomical and practical subjects. Of these the principal are, *A History of Anatomical Writers*.—*An Encheiridasis Anatomica*.—*Heads of many of his Lectures*.—*A Treatise on Comparative Anatomy*.—*A Treatise on Wounds and Tumours*.—*Observations on some Parts of Heister's Surgery*.—*An Oration de Cuticula*.

Few men were members of more Societies than he; still fewer equally assiduous in their attendance of those which in any way tended to promote public utility.—He was a manager of many public charities; and not only a member of different medical societies, but likewise of several others instituted for promoting literature, arts, sciences, and manufactures in Scotland, and was one of their most useful members. While he was held in high estimation at home, he was equally esteemed and respected abroad, and was elected member of the Royal Society at London, and an honorary member of the Royal Academy of Surgery at Paris.

He was not only very active in the line of his own profession, but as a citizen and general member of the community; for, after he had resigned
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the anatomical chair to his son, he executed with the strictest punctuality the duties of several engagements both of a civil and political nature*.

His character was not more conspicuous in public than it was amiable in private life. He was brought up under the tuition of a fond parent, and distinguished himself by the most exemplary filial piety, affording to an aged father every comfort that a man in the decline of life can well enjoy. The father, perfectly at ease with regard to the necessaries and conveniences of life, saw with the utmost pleasure an affectionate son, esteemed and regarded by mankind, the principal actor in the execution of his favourite plan, the great object of his life, the founding a seminary of medical education in his native country; and, three years after the first stone of the new hospital was laid, ended his days in a calm retreat at a pleasant country-seat which his son had purchased in the county of Berwick.—The son, who survived him near thirty years, had the satisfaction to behold this seminary of medical education frequented yearly by three or four hundred students, many of whom came from the most distant corners of his Majesty's dominions; and to see it arrive at a degree of reputation far beyond his most sanguine hopes, being equalled by few, and inferior to none, in Europe.

He had great humanity and sweetness of temper, and was endowed with a singular liberality of sentiment.—He was a sincere friend, and an agreeable companion; an affectionate husband, and a kind father; and was never more happy than when he could serve those whom he thought deserving.

He was a great friend to civil liberty, and steadily attached to the present royal family. After the unfortunate affair of Prestonpans in the year 1745, he flew to the field of battle, to assist the sick and wounded officers and soldiers in his Majesty's service; and after seeing their wounds dressed, he, by his singular activity, procured them provisions of every sort, and afterwards procured carriages for bringing them to town, where he attended them with the greatest assiduity and care. At the same time,

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his.

* He was a Director of the Bank of Scotland, a Justice of the Peace, a Commissioner of High-roads, &c.

his humanity led him to give assistance to many of the wounded rebels, who, from their wounds, had become objects of compassion, even though engaged in a cause which he did not approve of. The same humanity led him, after the rebellion, to represent to government the assistance he had got from some of the rebel officers in procuring provisions and necessaries for the wounded officers and soldiers in his Majesty's service on that occasion, which contributed to procure them pardons. And having by accident got certain information that the late unfortunate Dr Cameron, who was so active in the time of the rebellion, had endeavoured to persuade the Pretender, on his first landing in Scotland, to return to France without attempting an insurrection, and had even left him with a full resolution of taking steps to prevent a rebellion, but was disappointed by some of his relations joining the Pretender sooner than he expected, making himself in a manner prisoner, and over-persuading him to join them; our Author, alongst with the late Earl of Morton President of the Royal Society, drew out a memorial representing these facts, which Lord Morton laid before the late King and Council while Dr Cameron was under confinement; and his late Majesty, who was always inclined to mercy, afterwards informed Lord Morton that he would certainly have had a pardon, had it not been for certain information of some treasonable practices that were going on at the time he was apprehended, in which the Doctor was suspected to be concerned.

Dr ALEXANDER MONRO, in the beginning of the year 1725, married Miss Isabella Macdonald, second daughter of Sir Donald Macdonald of Macdonald, in the Isle of Sky, Baronet, by whom he had eight children, four of whom died young; the other four are still alive, viz.

JOHN MONRO, Esq; of Auchinbowie, Advocate, Counsellor at Law.

Dr DONALD MONRO, Physician to the Army and to St George's Hospital, London.

Dr ALEXANDER MONRO, Physician, and Professor of Medicine and of Anatomy and Surgery at Edinburgh; and Mrs PHILP, wife of James Philp, Esq; Judge of the Court of Admiralty for Scotland.

To them our Author proved a most affectionate father. In their youth, he not only superintended their education, but was himself their master
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in several branches; and when they grew up, he made them his companions and friends.

He was a man of a strong muscular make, of a middle stature, and possessed of great strength and activity of body; but subject for many years to a spitting of blood on catching the least cold, and through his whole life to frequent inflammatory fevers; which he used to attribute to the too great care his parents took of him in his youth, and to their having had him regularly blooded twice a-year, which in those days was looked upon as a great preservative of health.

In the year 1762, he was attacked with the epidemical catarrhal fever called *influenza*, attended with pain and uneasiness in making water and going to stool, which remained ever after during his life, and were the first symptoms of that long and painful disorder, a fungous eroding ulcer of the rectum and bladder, which put an end to his life. The disorder increased by slow degrees; and, from May 1766 to July 10th 1767, the day on which he died, gave him so constant and great pain, that he had little respite from it except by the force of opium. This long and painful disorder he suffered with the fortitude of a man and the resignation of a Christian; never once repining at his fate; but conscious of having acted an upright part, and of having spent his life in the constant exercise of his duty, he viewed death without horror, and talked of his own dissolution with the same calmness and ease as if he were going to sleep.

Such was the life of our author; and we shall conclude this long narrative with a letter written from the late John Forbes, Esq; of Culloden, (son to that great and excellent man, the late Duncan Forbes, Esq. * Lord President of the Court of Session), to one of his sons, on hearing of his death.

Dear Sir,

I most heartily condole with you on the loss of your worthy father, with whom my family have been so long and so intimately connected. I can, from my own experience, imagine what you must feel on this occasion; but, though nature must have its due, we ought not to forget what both
of

* So great an opinion had the public of the many services Mr Forbes had done his country, and of his integrity as a judge, that after his death the gentlemen of the law had a statue of him erected in the court of justice over which he presided.

of us owe to Providence for the lasting honour our fathers have done to their country, and to their families, in their different professions. They will be venerated as public blessings, while religion, virtue, and useful learning, remain; and we have only to follow them, and enforce their good example, to the best of our powers. I remain, with the sincerest wishes for your happiness, Dear Sir, -

HAMPSTEAD, }
 July 17. 1767. }

Your most obedient humble servant,
 JOHN FORBES.

P O S T S C R I P T.

AS perhaps the history of our Author's disorder of which he died, written by himself in June 1766, in a letter to his son Dr Donald, together with an account of the appearance of the diseased parts observed in his body after death, may not be unacceptable to the reader, we shall here subjoin them by way of postscript.

Copy of a LETTER from Dr ALEXANDER MONRO senior, to his son Dr DONALD at London.

Dear Donald,

I AM at present confined to the house, after a severe feverish disorder. My state has been such for some years past, that I have expected to be laid aside from business, and that my life will not be of long duration; but I shall little regret my dismissal from this world, if you are all once in an easy way of living. My case is this. In May 1762, I had the epidemic influenza, which affected principally the parts in my pelvis, so that I had a difficulty and sharp pain in making water and going to stool. My belly has never since been in a regular way, passing sometimes for several days nothing but bloody mucus, and that with considerable tenesmus; then, after suffering severe gripes, discharging as much faeces as I would have done formerly in a week, without scybala or water. Several times these gripes produced something very like to the iliac passion; to wit,

a severe fixed pain three inches below the navel and a little to the left side, with smart fever, vomiting, &c. By blood-letting, and the use of cooling and laxative medicines and clysters, &c. these first violent attacks were in a great measure got the better of, but left behind them an irregularity and stoppage of stools. About a year ago I was attacked with a frequent desire of making water, attended with heat and pain; and the frequent and sudden calls to these discharges made me decline being engaged in company. Last harvest I happened to observe my urine to be of a very red colour; and on examining it found small knots of mucus and blood mixed with it, in which way it has continued ever since. I found no change from diet or any medicines I took, which were laxatives, mild mucilaginous decoctions, bark, flowers of sulphur, uva ursi, &c. About a fortnight ago I had the addition of a swelling and inflammation of my right *testis*, the pain of which was removed by bleeding and emollient fomentations and cataplasms, though a little of the swelling still continues. No external hæmorrhoids appear, and, so far as the finger can reach, there are no tubercles nor hard knots within the rectum.

You know I was always subject to feverish disorders, and had several times the hæmoptoe in my early manhood, and afterwards had several times the piles; and some bloody evacuations have been made by stool since the year 1762. I never had any uneasiness in my kidneys, and have no right to gout or gravel either from my parents or from my own way of life. What do you think may be the disorder, and proper method of cure?

Whatever may be my state, believe me that your welfare will ever be one of my great concerns.

EDINBURGH, }
June 11. 1766. }

I am your's affectionately,

ALEX. MONRO.

After this, variety of medicines were recommended to him, but all without effect; his disorder gained daily ground, with an increase of pain and uneasiness, attended with various symptoms at different times, viz. purging, fainting fits, costiveness, difficulty of making water, &c. He passed for some time blood and mucus, and thin matter likewise mixed with

with his water ; and some time before death, the urine used to be mixed with air and excrement, and frequently it came away by stool.

On opening his body after death, there were found a preternatural adhesion of the rectum to the upper and back part of the bladder ; a fungous ulcerous appearance, two fingers-breadth, occupying the whole circle of the rectum, in which the disease probably began ; and an opening, above an inch in diameter, from the rectum into the top of the bladder, which last was otherwise found.

A N
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ART of INJECTING the VESSELS of ANIMALS.

THE method of filling the vessels of animals with a coloured liquor, which afterwards hardens, and, by keeping the vessels distended and firm, gives an opportunity of observing more exactly their distribution, situation, and diameters, and of discovering numbers of their branches and communications that would otherwise be unsearchable, is a modern improvement that has contributed considerably to explain the animal œconomy. Anatomists are now sufficiently acquainted with the manner of filling the larger trunks; but few have hit on the art of injecting the very small capillary tubes: wherefore I hope it will not be unacceptable to give a detail of what I have found, after a considerable number of different trials, to have succeeded best in this way of injection; which may at least have one good effect, though I should fail of being the discoverer of this art, namely, of saving unnecessary trouble to other inquirers after it, and may spur on some other more lucky person to communicate the whole of it, by which, more anatomists being employed in searching out the minute vessels, more discoveries may be made than when it is confined to so few as it is at present.

In describing the trials I have made to succeed in subtile injections, I can scarce help mentioning several things which are commonly known to all who practise injections of any kind; and I shall be the less anxious to shun them, that scarce any anatomical books describe with accuracy the method of injecting; and therefore this essay may save the young unexperienced anatomist the trouble of fruitless trials.

The instrument with which the liquor is commonly thrown into the vessels is a tight easy-going syringe of brass, to which several short pipes are fitted, and can be fixed by screws, the other extremities of these pipes being of different diameters without any screw, that they may slide into other pipes which are so exactly adapted to them at one end, that, when they are pressed a little together, nothing can pass between them: And because their cohesion is not so great as to resist the pushing force of the injection, which would drive off this second pipe, and spoil the whole operation; therefore the extremity of this second sort of pipes, which receives the first kind, is formed on the outside into a square, bounded behind and before by a rising circle, which hinders the key that closely grasps the square part from sliding backwards or forwards; or a bar of brass must stand out from each side of it to be held with the fingers. The other extremity of each of these second sort of pipes is of different diameter; and near it a circular notch, capable of allowing a thread to be sunk into it, is formed: by this the thread tying the vessel at which the injection is to be made, will not be allowed to slide off.

Besides this form described, common to all this second sort of pipes, we ought to have some of the larger ones with an additional mechanism for particular purposes. For instance, when the larger vessels are injected, the pipe fastened in the vessel ought either to have a valve or a stop-cock that may be turned at pleasure, to hinder any thing to get out from the vessel by the pipe; otherwise, as the injection in such a case takes time to coagulate, the people employed in making the injection must either continue all that while in the same posture, or, if the syringe is too soon taken off, the injected liquor runs out, and the larger vessels are emptied. When the syringe is not large enough to hold at once all the liquor necessary to fill the vessels, there is a necessity of filling it again:

again: If, in order to do this, the syringe was to be taken off from the pipe fixed in the vessel, some of the injection would be lost, and what was exposed to the air would cool and harden; therefore some of the pipes ought to have a reflected curve tube coming out of their side, with a valve so disposed that no liquor can come from the straight pipe into the crooked one, but, on the contrary, may be allowed to pass from the crooked to the straight one: the injector then taking care to keep the extremity of the reflected pipe immersed in the liquor to be injected, may, as soon as he has pushed out the first syringeful, fill it again by only drawing back the sucker; and, repeating this quickly, will be able to throw several syringefuls into the vessels.

All these different sorts of pipes are commonly made of brass.

The liquors thrown into the vessels with a design to fill the small capillary tubes, are either such as will incorporate with water, or such as are oily; both kinds have their advantages and inconveniencies, which I shall mention in treating of each, and shall conclude with that which I have found by experience to succeed best.

All the different kinds of glue, or ichthyocolla, fyths, common glue, &c. dissolved and pretty much diluted, mix easily with the animal-fluids, which is of great advantage, and will pass into very small vessels of a well-chosen and prepared subject, and often answer the intention sufficiently, where the design is only to prepare some very fine membrane, on which no vessels can be expected to be seen so large as the eye can discover, whether the transverse sections of the vessels would be circular, or if their sides are collapsed. But when the larger vessels are also to be prepared, there is a manifest disadvantage to the usefulness and beauty of the preparation: for if nothing but the glutinous liquor is injected, one cannot keep a subject so long as the glue takes of becoming firm; and therefore, in dissecting the injected part, several vessels will probably be cut and emptied. To prevent this, one may indeed either soak the part well in alcohol, which coagulates the glue; but then it becomes so brittle, that the least handling makes it crack; and, if the preparation is to be kept, the larger vessels appear quite shrivelled when the watery part of the injection is evaporated: Or the efflux of the injection may be prevented by carefully tying every vessel before we are obliged to cut it; still,

however, that does not hinder the vessels from contracting when the glue is drying. If, to obviate these difficulties, the glutinous liquor should first be injected in such quantity as the capillary vessels will contain, and the common oily or waxy injection is pushed in afterwards to keep the larger vessels distended; the wax is very apt to harden before it has run far enough, the two sorts of liquors never miss to mix irregularly, and the whole appears interrupted and broken by their soon separating from each other; which is still more remarkable afterwards, when the watery particles are evaporated.

Spirits of wine coloured mixes with water and oils, and so far is proper to fill the very small vessels with; but, on the other hand, it coagulates any of our liquors it meets, which sometimes block up the vessels so much, that no more injection will pass: then it scarce will suspend some of the powders that prove the most durable colours; and as it entirely evaporates, the vessels must become very small; and the small quantity of powder left, having nothing to serve for connecting its particles together, generally is seen so interrupted, that the small ramifications of vessels rather have the appearances of random scratches of a pencil, than of regular continued canals.

Melted tallow, with a little mixture of oil of turpentine, may sometimes be made to fill very small vessels, and keeps the larger ones at a full stretch: but where any quantity of the animal-liquors is still in the vessels, it is liable to stop too soon, and never can be introduced into numbers of vessels which other liquors enter; and it is so brittle, that very little handling makes it crack, and thereby renders the preparation very ugly*.

The method I have always succeeded best with, in making what may be called subtle or fine injections, is, first to throw in coloured oil of turpentine, in such a quantity as might fill the very small vessels; and
immediately

* Rigierus (*introduc. in notitiam rerum natur. et artefact. 4to, Haga 1843, titul. Balsamum*) gives Ruysch's method of injecting and preserving animals, which, he says, Mr Blumentrost, president of the Petersburg academy, assured him was copied from the receipt given in Ruysch's own hand-writing to the Czar. According to this receipt, melted tallow, coloured with vermilion, to which, in the summer, a little white wax was added, was Ruysch's injecting *ceracea materies*.

immediately after to push the common coarse injection into the larger ones. The oil is subtil enough to enter rather smaller capillary tubes than any colouring can; its resinous parts, which remain after the spirituous are evaporated, give a sufficient adhesion to the particles of the substance with which it is coloured, to keep them from separating; and it intimately incorporates with the coarser injection, by which, if the injection is rightly managed, it is impossible for the sharpest eye to discover that two sorts have been made use of*.

All the liquors with which the vessels of animals are artificially filled, having very faint and near the same colours, would not at all appear in the very small vessels, because of their becoming entirely diaphanous, without a mixture of some substance to impart its colour to them; and where several sorts of even the larger vessels of any part were filled, one sort could not be distinguished from another, unless the colour of each was different; which has likewise a good effect in making preparations more beautiful. Wherefore anatomists have made use of a variety of such substances, according to their different fancies or intentions, such as gamboge, saffron, ink, burnt ivory, &c. which can be easily procured from painters. My design being only to consider those that are fit to be mixed with the injecting liquors proposed to fill capillary vessels, which is scarce ever to be done in any other, except the branches of the arteries and of some veins, I shall confine myself to the common colours employed to these last-named two sorts of vessels, which colours are red, green, and sometimes blue, without mentioning the others which require very little choice.

Anatomists have, I imagine, proposed to imitate the natural colours of the arteries and veins in a living creature, by filling the arteries with a red substance, and the veins with a blue or green: from which, however, there are other advantages; such as, the strong reflection which such bodies make of the rays of light, and the unaptness most such bodies have to transmit these same rays, without at least a considerable reflection of the

* Mr Ranby's injecting matter, as published by Dr Hales, (*Hæmaph. ex. 21.*), is white rosin and tallow, of each two ounces, melted and strained through linen; to which was added three ounces of vermilion, or finely ground indigo, which was first well rubbed with eight ounces of turpentine varnish.

the rays peculiar to themselves, or, in other words, their unfitness to become completely pellucid; without which the very fine vessels, after being injected, would still be imperceptible. The animal or vegetable substances made use of for colouring injections, such as chochineal, laque, *rad. anchusæ*, brazil-wood, indigo, &c. have all one general fault of being liable to run into little knots which stop some of the vessels; their colour fades sooner when kept dry; they more easily yield their tincture when the parts are preserved in a liquor; and rats, mice, and insects will take them for food: for which reasons, though I have frequently succeeded in injecting them, I rather prefer the mineral kind, such as minium or vermilion, for red; of which this last is, in my opinion, the best, because it gives the brightest colour, and is commonly to be bought finely levigated. The green-coloured powder generally used is verdigrease; but I rather choose that preparation of it called *distilled verdigrease*, because its colour is brighter, and it does not so often run into small knots as the common verdigrease, but dissolves in the oily liquors.

The method of preparing the injection composed of these materials, is to take, for the fine one, a pound of clear oil of turpentine, which is gradually poured on three ounces of vermilion or distilled verdigrease finely powdered, or rather well levigated by grinding on marble; stir them well with a small wooden spatula till they are exactly mixed, then strain all through a fine linen rag. The separation of the grosser particles is, however, rather better made, by pouring some ounces of the oil upon the powder; and, after stirring them together strongly, stop rubbing with the spatula for a second or so, and pour off into a clean vessel the oil with the vermilion or verdigrease suspended in it; and continue this sort of operation till you observe no more of the powder come off, and all that remains is granulated. The coarser injection is thus prepared: Take tallow, one pound; wax, bleached white, five ounces; salad oil, three ounces: melt them in a skillet put over a lamp; then add Venice turpentine, two ounces; and as soon as this is dissolved, gradually sprinkle in of vermilion or verdigrease prepared, three ounces: then pass all thro' a clean, dry, warmed linen-cloth, to separate all the grosser particles; and when you design to make it run far into the vessels, some oil of turpentine may be added immediately before it is used.

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The next thing to be considered, and indeed what chiefly contributes to the success of injections, is the choice and preparation of the subject whose vessels are to be filled.

In choosing a fit subject, take these few general rules: 1. The younger the creature to be injected is, the injection will, *cæteris paribus*, go farthest, and *vice versa*. 2. The more the creature's fluids have been dissolved and exhausted in life, the success of the operation will be greater. 3. The less solid the part designed to be injected is, the more vessels will be filled. 4. The more membranous and transparent parts are, the injection flows better; whereas in the solid very hard parts of a rigid old creature, that has died with its vessels full of thick strong blood, it is scarce possible to inject great numbers of small vessels.

Therefore, in preparing a subject for injecting, the principal things to be aimed at are, To dissolve the fluids, empty the vessels of them, relax the solids, and prevent the injection's coagulating too soon. To answer all these intentions, authors have proposed to inject tepid or warm water by the arteries, till it returns clear and untinged by the veins; and the vessels are thereby so emptied of blood, that all the parts appear white: after which they push out the water, by forcing in air; and, lastly, by pressing with their hands, they squeeze the air also out. After this preparation, one can indeed inject very subtilely, but generally there are inconveniencies attend it: for in all the parts where there is a remarkable *tunica cellulosa*, it never misses to be full of the water, which is apt to spoil any parts designed to be preserved either wet or dry; and some particles of the water seldom miss to be mixed in the larger as well as smaller vessels with the oily injection, and make it appear discontinued and broken. Wherefore it is much better to let this injection of water alone, if it can be possibly avoided, and rather to macerate the body or part to be injected a considerable time in water made so warm * as one can hold his hand easily in it: taking care to keep it of an equal warmth all the time, by taking out some of the water as it cools, and pouring in hot water in its place; by which the vessels will be sufficiently softened
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* Ruysch orders a previous maceration for a day or two in cold water; which must have a better effect in melting the blood than warm water has.

and relaxed, the blood will be melted down, and the injection can be in no danger of hardening too soon; whereas if the water is too hot, the vessels shrink, and the blood coagulates. From time to time we squeeze out the liquids as much as possible at the cut vessel by which the injection is to be thrown in *. The time this maceration is to be continued, is always in proportion to the age of the subject, the bulk and thickness of what we design to inject, and the quantity of blood we observe in the vessels, which can only be learned by experience: at least, however, care ought to be taken, that the whole subject or part macerated is perfectly well warmed all through; and that we continue the pressure with our hands, till no more blood can be brought away, whatever position we put the subject in.

When the syringe, injections, and subject, are all in readiness, one of the second sort of pipes is chosen, as near to the diameter of the vessel by which the injection is to be thrown as possible: for if the pipe is too large, it is almost needless to tell it cannot be introduced; if the pipe is much smaller than the vessel, it is scarce possible to tie them so firmly together, but, by the wrinkling of the coats of the vessel, some small passage will be left, by which part of the injection will spring back on the injector in the time of the operation, and the nearest vessels remain afterwards undistended by the loss of the quantity that oozes out. Having chosen a fit pipe, it is introduced at the cut orifice of the vessel, or at an incision made in the side of it; and then a waxed thread being brought round the vessel, as near to its coats as possible, by the help of a needle, or a flexible eyed probe, the surgeon's knot is made with the thread, and it is drawn as firmly as the thread can allow: taking care that it shall be sunk into the circular notch of the pipe, all round; otherwise it will very easily slide off, and the pipe will be brought out probably in the time of the operation, which ruins it.

If there have been large vessels cut, which communicate with the vessels you design to inject; or if there are any others proceeding from the same trunk, which you do not resolve to fill; let them be all carefully
now

* When Ruysch intended to inject the whole body, he put one pipe upwards and another downwards, in the descending aorta.

now tied up, to save the injected liquor, and make the operation succeed better in the view you then have.

When all this is done, both sorts of injections are to be warmed over a lamp, taking care to stir them constantly, lest the colouring powder fall to the bottom and burn *. The oil of turpentine needs be made no warmer than will allow the finger to remain in it, if the subject has been previously well warmed in water: when the maceration has not been made, the oil ought to be scalding hot, that it may warm all the parts which are designed to be injected. The coarse injection ought to be brought near to a boiling. In the mean time, having wrapped several folds of linen round the parts of the syringe which the operator is to gripe, and secured the linen with thread, the syringe is to be made very hot, by sucking boiling water several times up †; and the pipe within the vessel is to be warmed, by applying a sponge dipped in boiling water to it ‡.

After all is ready, the syringe being cleared of the water, the injector fills it with the finer injection; and then introducing the pipe of the syringe into that in the vessel, he presses them together, and either with one hand holds this last pipe firm, with the other gripes the syringe, and with his breast pushes the sucker; or, giving the pipe in the vessel to be held by an assistant, in any of the ways mentioned in the description of these sort of pipes, he gripes the syringe with one hand, and pushes the sucker with the other; and consequently throws in the injection, which ought to be done slowly, and with no great force, but proportioned to the length and bulk of the part to be injected, and strength of the vessels. The quantity of this fine injection to be thrown in is much to be learned by use. The only rule I could ever fix to myself in this matter, was to continue pushing till I was sensible of a stop which would require a considerable force to overcome. But this will not hold where all the

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branches

* Ruysch melts his tallow by the heat of warm water, into which he puts the vessel containing the injection.

† He warms his syringe by laying it on hoat coals.

‡ He warms his pipe, by putting the body, after the pipe is fixed in the vessel, into hot water. When this is to be done, a cork ought to be put into the pipe, to prevent the water from getting into the vessel that is to be injected.

branches of any vessel are not injected; as, for instance, when the vessels of the thorax only are to be injected; for the aorta bears too great a proportion to the branches sent from it, and therefore less fine injection is requisite here. As soon as that stop is felt, the sucker of the syringe is to be drawn back, that the nearest large vessels may be emptied: then the syringe is taken off, emptied of the fine injection, and filled with the coarser, which is to be pushed into the vessels quickly and forcibly, having always regard to the strength and firmness of the vessels, bulk, &c. of the part. Continue to thrust the sucker till a full stop, or a sort of push backwards, is felt; when you must beware of thrusting any more, otherwise some of the vessels will be bursted, and the whole, or a considerable share of the preparation you designed, will be spoiled by the extravasation; but rather immediately stop the pipe by the turn-cock, and take out the syringe to clean it, and allow sufficient time for the coarse injection to coagulate fully before any part is dissected*.

In this way I have frequently injected the cortical part of the brain, *tunica choroides* and *vasculosa* of the eye, *periosteum* of the bones of the ear, vessels of the teeth, of the skin, bones, and viscera. As a specimen of the success of this way, in Plate I. is given the figure of a little piece of the *tunica villosa* of the intestines, at least of that membrane which retains the air in the internal cellular coat of the intestines, when they are turned inside out, and these cellules are distended by blowing. Fig. 1. represents this piece of membrane as it appears to the naked eye; only that the deep red colour, with which it is tinged all over in the original, cannot appear here. In fig. 2. is represented the appearance it had when viewed with a microscope. What looks like a sort of moss-work here, shews itself vascular when it is viewed with a microscope that magnifies more than the one employed when the painter drew this figure.

* Ruyfch, immediately after throwing in the injection, put the body into cold water, and stirred it continually for some time, to prevent the separation of the vermilion from the tallow.

A N
E S S A Y
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Method of preparing and preserving the Parts of Animal-
Bodies for Anatomical Uses.

THE most artful management of the knife alone cannot discover the texture of animals sufficiently: Anatomists are therefore obliged to employ several other arts, which often require a considerable time in their execution, and frequently fail through some unfitness in the subject, or by a very small omission or accident; and when they succeed in any attempt of this kind, they endeavour to preserve the parts thus prepared, that they may always be in readiness to supply what cannot be demonstrated on the recent subject. While each anatomist is obliged to his own industry only for the discovery of these arts of preparing and preserving, it is probable that frequent disappointments, and the despondency these will create, may discourage many from pursuing the study of anatomy, who might become the greatest improvers in it if these difficulties did not lie in their way. With a view to remove them in some measure, I shall give an account of such arts of preparing and preserving the parts of animal-bodies as I have found successful; which may serve as a foundation, on which others, more industrious or ingenious, may build.

The principal preparation that BONES require is to make them white; for which directions are given at considerable length by Paulli * and Lysferus †, who also teach the method of putting the bones of adults together. What I have found most successful for whitening the bones of

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young

* Act. Hafn. vol. ii. § 18.

† Cult. Anat. lib. 5.

young creatures, is macerating them long in cold water; which ought to be changed frequently, the bones being laid out each time to dry a little in the sun. If they lie too long in the water, even those of adults will dissolve in their more spongy parts, and the younger ones lose all their epiphyses. If they are allowed to dry before the blood in their vessels is melted down by the maceration, it scarce can be afterwards separated from them, or they will never become white. The marrow of young bones being much less oily than in adults, they generally can be made much whiter, and do not readily turn yellow by keeping. The bones of fœtuses require to be taken frequently out of the water; and the periosteum must not be separated where the epiphyses are joined, otherwise it is scarce possible to prevent the loss of these additional pieces.

The method of burning and exposing the bones of adults long to the weather, for unravelling their texture, is so generally known, that I need scarce mention it.

CARTILAGES are made pellucid in the same way that bones are whitened: and they must afterwards be brought to their natural shape and situation; in which they are to be kept by strings, weights, pins, and such other contrivances, if they are to be preserved dry.

The MUSCLES that have no large cavity are to be laid and secured in the posture they are designed to be preserved in; and they are pressed with the fingers into a natural shape while they are drying.

In the Medical Essays † are published all I know of the method of injecting the VESSELS. That they may appear better, it is necessary to macerate in cold water all injected parts that are coloured with blood, till the blood is extracted; after which the water is to be pressed well out: and even when the preparation is to be preserved wet, it is of service to let it dry a little in the air, before it is put into the embalming liquor. But before the very minute extremities of injected vessels can be demonstrated, there is a farther art requisite, which is the same that has been employed by several of late for unravelling the texture of leaves and fruits; of which Severinus*, near a century ago, says, “*Verum me ineptum, quid præterieram opontii folii resolutionem artificiosam: parabitur hæc porro simplici*

† Vol. I. art. ix.

* Th. Bartholin. Epist. Med. cent. 1. epist. 65.

“simplici tabefactu per affusam uberem aquam tamdiu complexuram,
 “dum fibris lignea duritie restibilibus, omnis exfolvatur carnea portio.”
 And Ruyfch † at last acknowledged his method of preparing the succous vessels of fruits, and of the brain, &c. to be the same. Put therefore the injected brain, lungs, liver, spleen, placenta, or any other part of a tender texture, into water: allow it to remain there, till its involving membrane is raised by the water insinuated into the cellular membrane which connects it to the parts below: then separate the membrane; and afterwards keep the part among the water, till the fibres, connecting the small vessels, are dissolved. This is known by shaking frequently the part among the water, which washes off the corrupted particles; and at last the succous vessels are seen distinct and floating in the water: then the preparation is taken out; and, by gently pressing, the water is squeezed from it, the remainder of it being washed away with some of the preserving liquor, into which it is immediately put; and, by a little twirl of the thread or hair by which it is suspended, the preparation is expanded, and the small vessels are separated.

It is difficult to divide nerves into their very small filaments, after they have got their firm coat from the *dura mater*; but before they are involved in that membrane, they are easily divided. Those that constitute the *cauda equina* are fittest for this purpose; for they are long, and their fibres adhere by very weak fine membranes. One of these chords being cut through where it comes off from the *medulla spinalis*, and where it is about to enter the *dura mater*, one end is secured with a hair, by which it is suspended in a basin of water; and, after macerating some time there, it is raised to the side of the basin, upon which it is laid, while one hand holding the hair, with the other a very small needle, fixed in a handle, is slightly stripped along the nerve. Let this operation be continued, till, upon twirling the nerve among the water, it is expanded into a fine web of very small fibres; when it is put into the embalming liquor. If the blood-vessels were previously injected, the hair must be tied on the end of the nerve nearest to the *dura mater*, that the trunk of the nerve and artery may appear together. When a piece of the *cauda equina* is
 thus

† Advers. Anat. dec. 3. § 2.

thus prepared, it shows very prettily; for each filament almost of the nerve appears with injected vessels upon it.

When a fine single MEMBRANE, such as the *pleura* or *peritoneum*, is to be preserved for demonstrating its arteries after an injection, as much of the cellular membrane, by which it is connected to the neighbouring parts, is to be saved, in dissecting it off, as can be done without spoiling the transparency of the membrane; for, when the cellular substance is wholly separated, very few continued ramifications of vessels can be seen, a great number of exceeding short extremities only appearing, which require a microscope to view them distinctly. When there is little fat lodged in the cells, the membranes of the cellular substance may be left without a possibility of observing them: when they are filled with fat, it must be pressed out as much as possible, after being well macerated. Even when membranes are to be preserved in a liquor, they are more easily kept extended in it, and their vessels are better seen, if they are previously dried. In doing this, they must be extended with pins or threads on a finely polished clean board; or it is rather better to keep them on the stretch while they are raised up from it, that they may bear no print of the board. After membranes are dried, their doubled edges, or other inequalities, are to be cut off with a pair of scissors.

Ruyfch * describes the manner of separating the *cuticula* and *corpus reticulare* from the skin, by stretching these common teguments, well freed from the fat, on a board, with the *cuticula* outmost; and then dipping all into boiling water, which loosens the *cuticula* and *corpus reticulare* so from the skin, that they are easily separated with a blunt knife or the thin ivory handle of a scalpel; then with the same instrument he separates the *corpus reticulare* from the *cuticula*, leaving them connected to each other, and to the skin in some part. After this they may be either dried, or put into the embalming liquor. When either the *corpus reticulare* is not made firm enough by the hot water, or happens to be very thin, it is difficult to separate any considerable piece of it entire from the *cuticula*.

A chirotheca or podotheca, a glove or a shoe of the scarf-skin, with the nails adhering to it, is brought off with very little trouble after the
cuticula

* Adv. Anat. dec. 3. § 2.

cuticula loosens from the parts below by the putrefaction which keeping a subject long brings on. This method answers the design better than forcing off the scarf-skin with boiling water, which makes the *cuticula* tender.

The cellular membrane under the skin cannot be preserved distended with air, except where there is little or no fat contained in it. One of the best parts for making a preparation of this kind is the *scrotum*; where, what is commonly called *musculus dartos* may, by blowing into it, be changed entirely into fine membranous cellules: and Carolus Stephanus * very well observed, that the cellular substance any where else under the skin, puts on a muscular appearance when the fat is wasted. Will not these observations serve as some apology for former anatomists, who reckoned a *tunica carnea* among the common teguments of the body? May we not hence see one reason of old emaciated people having so many wrinkles in their skin?

That the DURA MATER, with all its processes, may be preserved in a natural situation, it is necessary to saw the *cranium* from near the root of the nose to the middle of the *os occipitis*, by a perpendicular section at half an inch distance from the *sagittal suture*, and then by an horizontal section, terminating at the extremities of the former perpendicular section, to take off a considerable share of the side of the *cranium*: after which, the *dura mater* being cut by an incision in form of a T, the brain and *cerebellum* are taken out, and the head is put amongst a liquor to preserve it; or the bones are made clean and exposed to the air to dry; taking care to keep the cut parts of the *dura mater* stretched out with pins, hooks, or threads. If the head of a foetus, or of a very young child, is thus to be dried, the ligamentous membranes between the bones must be kept extended by sticks, cut of such a length, as, when put into the cavity of the *cranium*, their extremities may rest on the bones, and push them outwards.

The processes of the PIA MATER, which are placed in the interstices of the convolutions of the brain, may be easily separated entire with the *pia mater*, when that membrane is preternaturally thickened by diseases, as it frequently is: and, even in a sound state, large pieces of it may be

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* De Dissect. Part. Corp. Human. lib. ii. cap. 2.

got with its processes, after macerating the brain in water. As soon as it is separated, and the water pressed from it, it ought to be immersed in the embalming liquor; where it is to be kept extended by threads or small branches of plants.

The BRAIN requires no preparation, except either for demonstrating its succous vessels, the method of doing which I have already mentioned; or for hardening it, which I shall afterwards speak of.

Before the coats, humours, and vessels of the EYE, can be rightly prepared for preserving, so as to demonstrate all of them, it is necessary to coagulate the crystalline and vitreous humours, by immersing the eye for some time in a proper liquor; of which hereafter. After this, they will bear maceration in water, for the separation of the choroid and Ruyfch's coat.

The sebaceous glands and ducts of the eye-lids, appear much better after a subtil injection of the arteries, and the coagulation of their liquors, than in the recent body.

Dr Trew * has very justly observed, that, by macerating the EAR in water, the membrane which is continued from the *epidermis* of the ear to line the *meatus auditorius externus*, and to form the outer lamella of the *membrana tympani*, may be brought off entire in adults, as well as it is easily separated in fœtuses or very young children. And indeed the *membrana tympani* appears to be no other than this *cuticula* and the membrane that lines the *tympanum*, connected by a thin cellular substance, in which, as in all other such parts of the body, the larger branches of the vessels run.

The *epithelia* of the LIPS, as Ruyfch calls the *cuticula* covering the *papillæ* there, is to be taken off by macerating in water; which makes the surface appear better in the villous way, when the lips are afterwards put into a glass with the embalming liquor.

The villous substance of the TONGUE is very easily made quite red with injection thrown in by the arteries; and a membrane analogous to a *cuticula* separates by soaking in water: and, upon comparing the lips, tongue, œsophagus, stomach, and intestines, the structure seems to be so far alike in all, as they are covered with this sort of *cuticula*; which is connected

* Act. Physico-medic. Acad. N C. vol. ii. obs. 56.

connected to the muscular part by a cellular substance, in which the numerous nerves, vessels, and glands, are lodged. This cellular substance either is formed into ridges and valves where it is thick and loose, or appears like a fine membrane where it is thin and stretched.

There are no organs in the body of which I find a greater difficulty to give the students of anatomy a good idea, than those employed in deglutition. In the recent body, they cannot see them all at once in the natural situation; they can scarce be held in a wet preparation, so as to shew them well enough. What has the best effect, is to demonstrate the grosser parts first in a dry preparation; which requires patience to execute right: for all the muscles belonging to these organs, that are fixed to any of the surrounding parts, must be all clean dissected, and then cut off from these surrounding parts; after which the tongue, *os hyoides*, *fauces*, *velum pendulum palati*, with the *uvula*, the *larynx*, *pharynx*, *aspera arteria*, and *œsophagus*, are taken out with the dissected muscles hanging at them, to be all secured in their natural situation with small pieces of thin boards, and threads fastened to hooks: a cork is then put into the lower part of the *trachea*; round which and the *œsophagus* a strong thread is tied firmly, and quicksilver is poured by the *fauces*, or by the passage which formerly led to the nostrils, till the *œsophagus*, *trachea*, *larynx*, and *pharynx*, are filled: in which condition it is allowed to hang till the parts are pretty firm, but not near fully dry; when the quicksilver is poured out; and the parts overstretched by its weight, such as the *glottis* and space between the tongue and *larynx*, are, by pressing and squeezing with the fingers, to be brought near to the natural situation; and others that shrivel too much, as, for instance, the *uvula* and *epiglottis*, are kept near to the natural form, by drawing and pressing them from time to time till they are fully dried.

The hollow VISCERA of the *thorax* and *abdomen* are not only to have their vessels demonstrated in the ways mentioned formerly, when speaking of the blood-vessels; but, when they are to be kept dry, they require a particular preparation for preserving their form, and for showing their interior structure; which is to fill them with some proper substance. The properties I think this should have are, to be able to resist the shrivelling contraction of their fibres, to fill them all equally, and to leave

them clean if it should be taken out. For these reasons, cotton, wool, sand, or such like, are improper: all that I use is air, quicksilver, or melted wax.

Wax is only to be employed where there is no farther design than to view the exterior surface; for which purpose it may be thrown into any of the hollow bowels: but in all other cases, air or quicksilver must be used.

Where air will answer the design, it is preferable to the quicksilver, for it stretches every where equally; whereas mercury presses most on the depending parts. Air dries the bowels in the twentieth part of the time that quicksilver does; and it leaves no colouring or gilding on them, which the mercury always does. On the other hand, air does not stretch some parts sufficiently, cannot be retained, and insensibly escapes so from others, as to allow them to collapse in drying; which inconveniencies the quicksilver is not so subject to.

From what has been said, it is evident, that air is required, or is much preferable to quicksilver, for making dry preparations of the *œsophagus*, stomach, guts, *vesica fellea*, with the biliary ducts, and bladder of urine, with the ureters. And it is as plain, on the other side, that the *pericardium* and *uterus* can only be kept distended in their natural form with mercury. The heart with its blood-vessels, and the *pelvis* of the kidney with the ureter, generally have some small passages for the air to escape at, and it scarce can resist the shrivelling contraction of their fibres; wherefore mercury is preferable in drying them. The *corpora cavernosa penis*, and the *vesiculæ seminales*, retain both air and mercury: but this last leaves a gilding in the *corpora cavernosa*, which hinders such a clear view as could be wished of their vessels and texture; and there is a difficulty to fill the *vesiculæ seminales* with it, for the orifices at the *caput gallinaginis* will not admit it from the *urethra*: and when it is poured in at the *vas deferens*, the moisture of this narrow pipe is liable to stop it; and after you have got it to run in this canal, its weight forces open the orifice into the *urethra* of the small duct common to the *vas deferens* and *vesicula seminalis*, so that it will not mount into the *vesicula* till the *urethra* is filled: whereas the contraction of that orifice resists a small blast of air, which readily regurgitates into the vesicula. For which reasons, air is
preferable

preferable for the *corpora cavernosa* and *vesiculæ seminales*.—It is seldom we meet with subjects whose lungs or spleen will retain air; and the glans of the penis is very liable to allow it to escape: wherefore, generally, we are obliged to make use of quicksilver for these parts; which, however, does considerable prejudice in all of them, but especially in the lungs and glans, whose cellules are smaller than those of the spleen.

Being determined, by the foregoing rules, which of the two liquors to use, we press out all the blood or other liquors contained in the bowels we design to fill, and then tie all the passages from them, except the one by which we are to introduce the distending liquor: and in case we discover any others in the time of filling them, at which the air or quicksilver escapes, we tie them likewise.

The passage by which the liquors should be introduced, is to be chosen such as soonest allows them to pass every where into the cavity to be filled, and that is most easily secured afterwards. What was said of the organs of deglutition, will readily lead one to know how to distend the *pericardium* and *uterus*. The place for blowing up the alimentary tube, *vesica fellea*, and *urinaria*, is known to every body. Liquors are poured into the heart and large arteries through the superior *vena cava* and any branch of the pulmonary veins. The *trachea arteria* receives what the lungs are to be distended with; the kidney is to be filled by the ureter; the veins of the spleen, *capsula atrabilaris*, and *corpora cavernosa penis*, are to convey the substance with which they are distended.

We must always make use of a pipe when we are to blow up any part. The best sort of pipe for this use is what has a small extremity, with a notch round it, and a stop-cock a little higher in it. We introduce the small extremity into the proper canal, which is tied upon it with a waxed thread, that is made to sink into the notch; and as soon as the bowel is sufficiently distended, the stop-cock is turned, to prevent the air to get out. If any of it escapes, it is easily supplied by a new blast at the pipe, which is supported by some string or board, to hinder it to press or draw the preparation while it is drying.—If the anatomist is provided with no other than a common blow-pipe, the canal by which the air is introduced must be tied tight upon it with a thread, which is drawn with a firm knot by an assistant, while the air is blown in. As soon as the

bowel is sufficiently distended, a signal is given to the assistant for pulling the ends of the thread, while the pipe is drawn out of the canal; and immediately another knot being made, the preparation is suspended by this thread.

When quicksilver is employed, the passage by which it is poured must be higher than any other part of the preparation; and when that passage is narrow, a small glass funnel or pipe must be put into it. This pipe must be long, where the weight of a high column of mercury is wanted to make it run through small vessels. If the preparation will allow, the passage by which the mercury entered is to be tied firmly; otherwise, before any mercury is poured in, that passage must be secured, so as to remain uppermost all the time the preparation is drying.—When a considerable quantity of mercury is poured into any part whose texture is tender, it is necessary not only to suspend it with threads and hooks in the superior part, but to support it also by a small net extended below it, upon a proper vessel for receiving the quicksilver, if by any accident it should run out.

The directions now given will serve for preparing the most part of the bowels; but the LUNGS and SPLEEN, whose membranes very difficultly retain either quicksilver or air, especially this last, require more care. These bowels must not be taken indifferently from any subject; but such must be chosen as have the exterior membrane thick and strong. After they have been distended as above directed, they should be exposed to the warm sun, or near a fire, to dry them soon; returning frequently to supply by a new blast what they lose in very little time. As soon as their outer surface is dry, immerse them into strong turpentine varnish, so as their whole surface may be covered; after which they will retain the air much better: continue to place them so that they may soonest dry, taking care to rub on varnish with a feather wherever it is wanting, and to blow in new air whenever they subside.

After the human spleen has been kept distended with quicksilver, or air, till it is dried, it seems to be wholly composed of cells communicating with each other; upon the sides of which the small branches of the artery are observed to spread in great numbers, if they have been previously injected.

Upon

Upon cutting the lungs thus prepared, their vesicles appear far from being spheres, or any other figure whose transverse section is circular; for they evidently are polygons, generally irregular squares and pentagons. And indeed one might conclude *a priori*, that they are rather more so in a living creature: for seeing the exterior membrane is of a firmer texture than the vesicles, and will not stretch out so far as they could be extended, they must push violently on each other; and therefore be pressed from a spherical form into as many sides and angles as there are contiguous vesicles: and the *thorax* of a living creature does not allow the lungs to be extended so far as their exterior membrane can be stretched, as is evident from their starting out at wounds of the *thorax*, or by blowing into the *trachea arteria*, after the *sternum* of a creature is taken away; and therefore their vesicles must be more compressed, and consequently their sides be straiter in respiration, than when they are distended after being taken out of the body. These considerations, and the obvious polygon form of the cells in the simple lungs of serpents, frogs, &c. make me surpris'd that ever the vesicles of more complicated lungs should have been imagined to be spheres, or any other figure whose transverse section is circular.

I come now to consider the manner of preserving preparations: which is, either by exposing them to the air till all their moisture is evaporated, and they become dry, rigid, and out of hazard of corrupting; or by immersing them in a proper liquor. Besides what has been already said concerning the manner of drying preparations, it is also necessary, especially when the parts are thick and bulky, and the weather is warm, to guard further against putrefaction; to hinder flies from laying their eggs upon them, which soon growing into maggots would destroy them; and to prevent insects, mice, or rats, from feeding on them. All this may be done, by soaking the preparation, some time before it is exposed to dry, in a solution of corrosive mercury in spirit of wine. The proportions I use are two drachms of the corrosive to a pound of the spirit; and while it is drying, it is to be moistened frequently with the same liquor. By this method one can, without any of the dangers above-mentioned, dry the dissected bodies of pretty large children in the midst of summer; which sooner answers the design than the cold moisture of winter can.

—After

—After the preparation is dry, it is still liable to moulder away, become brittle, crack, and have an unequal surface; wherefore it is necessary to defend all its surface with a thick varnish, with which it is to be covered over as often as the lustre of the former application wears off; and it must always be kept well from all dust and moisture. The varnish I always use is the common spirit one, which I buy from the painters*.

Dry preparations are very useful in several cases; but there are a great many where it is necessary the parts should be flexible, and nearer a natural state, than the shrivelling and rigidity in this way of preparing can allow. The difficulty has hitherto been, to find a liquor that would preserve them so near to a natural condition. Watery liquors do not prevent the putrefaction, and they dissolve the hardest parts of the body. Acids prevent putrefaction, but dissolve the parts into a mucilage. Ardent spirits harden the parts, change their colour, and destroy the red colour of the injected vessels. Oil of turpentine, besides the faults of the ardent spirits, becomes thick and viscous. But without dwelling longer on the faulty liquors, I shall observe, that what I have always found to answer best, is a rectified ardent spirit, no matter whether from wine or malt, that is still limpid, without having any yellow tincture, to which a small quantity of a fossil acid spirit, such as that of vitriol or nitre, is added: both of them resist putrefaction; and what might be looked on as faults, if each was considered singly, is mended by the other. When these are mixed in a right proportion, the compound liquor changes neither the colour nor consistency of the parts, except where there are serous or mucous liquors, which it hardens much in the way that boiling water does. The brain, even of a new-born child, is made so firm by it, that it can be handled with great freedom. The crystalline and vitreous humours of the eye become firm, but white and opaque, by soaking in it. The liquor of sebaceous glands, of mucous folliculi, the seed, &c. are coagulated by it. The lymphatic, or watery liquors, such as the aqueous humour of the eye, water of the *pericardium* and *amnios*, are not changed by it. It heightens the red colour of injected liquors so much, that vessels which did not at first appear are plainly seen, after the part has been in it some time.

* Ruyfch recommends a varnish made of *gum copal* and *ol. spica*.

time. If these effects are compared with what Ruysch has said here and there of his preparations, it will be found, that the liquor described comes pretty much up to the properties of his balsam, as he calls the liquor in which he preserved his wet preparations *.

The proportion of the acid to be mixed with the ardent spirit, is to be varied according to the part to be immersed in it, and the design the anatomist has. When the brain, humours of the eye, &c. are to be coagulated, a larger proportion of acid is necessary, such as two drachms of spirit of nitre to a pound of alcohol. When the parts are only to be preserved, especially if there are any bones in the preparation, forty, thirty, or fewer drops of the acid, will be sufficient. If too large a proportion of the acid is mixed, the bones become first flexible, and then dissolve.

After any part is embalmed, particular care must be taken to keep it always covered with the liquor; otherwise its colour spoils, and some parts harden, others dissolve. To prevent, therefore, the evaporation as much as possible, and to exclude the air, which makes the spirits extract a tincture, the mouth of the glass is to be carefully stopped with a glass or a waxed cork, cover, or stopper; over which, leaf-tin, a bladder, or injected membrane, is tied; in which way it will keep a considerable time without any great waste. Whenever the spirits sink near to the top of the preparation, more of the spirit of wine must be added, without the acid, which flies little off. If at any time the spirits acquire too high a tincture, they must be poured off, and new spirits, with a less proportion of the acid than at first, must be put in their place; the old ones being kept in a well-corked bottle, for washing away the natural liquors of any new preparation, which ought always to be carefully done before any part is embalmed; and the old tintured spirits are likewise to be washed off with a small quantity of limpid spirits, every time the old ones are renewed, or a new preparation is to be preserved. The spirits unfit to be longer shown in glasses, may also be still employed in preserving parts in earthen vessels, or glass ones, out of which the preparation must be taken when it is to be viewed.

It

* Ruysch's balsam, according to Rigierus, (*Notit. rerum natural. et artefact.*), is rectified spirit of malt (*frumenti*), to which a third part of water is added. Ruysch distilled this spirit in a tin alembic, with a slow fire; and thought that the addition of a handful of black pepper made the spirit penetrate better into the fleshy parts.

It may not be amiss to remark here, that the glasses in which preparations are to be demonstrated, ought to be of the finest most transparent thick kind: for these allow the parts to be seen most distinctly, without changing their colour, and at the same time magnify the objects; discovering parts which, when they are out of the glass, could not be seen with the naked eye. Since, then, the glass with the liquor has a certain focus where objects are seen most distinctly, it will be necessary to use some contrivance for keeping the preparation at the proper distance from the side of the glass; which may be done, by putting in a small branch of some plant, or a little stick, or by fastening the thread or hair by which the preparation is suspended towards one side of the glass. Such little arts, for keeping the parts expanded, or placing them so as to be seen to the best advantage, will easily occur to any one who practises anatomy.

I shall finish this essay with a caution to anatomists, to shun as much as possible putting their fingers into these acidulated spirits, or handling the preparations that are very wet with them; for they bring such a numbness on the skin for some time, as makes the fingers unfit for any nice dissection. The best cure I have used for this numbness, is washing the hands with water, into which a few guts of *ol. tartar. per deliquium* have been dropped.

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GENTLEMEN,

WHEN this *Osteology* was first printed in 1726, I did not know that Albinus, Winslow, and Palfyn, were to publish descriptions of the bones; otherwise my papers probably would have remained yet undelivered to the printers. I however flatter myself, that this *Essay* has been of use to the Gentlemen who did me the honour to attend my lectures, by assisting them to understand my sense and representation of things in this fundamental part of anatomy; nay, that it has possibly been of more advantage to them than a more complete work from an abler hand, unless my demonstrations had been in the order and method of such an author.

This view of your improvement, Gentlemen, is a prevailing argument with me to cause this essay to be reprinted; and you cannot reasonably blame me, if I likewise acknowledge another motive for it, which more particularly relates to myself. In a new edition, an author has an opportunity of making his works more correct, complete, and consequently acceptable to the public; who may perhaps be indulgent enough to think this little treatise not altogether useless, since more reasoning on the structure and morbid *phænomena* of bones is to be found in it than in the other writers, who have confined themselves almost entirely to the descriptive or proper anatomical part of the *osteology*.

I have here kept to the plan of the former editions; by first considering, in the order that seemed to me most natural and methodical, every

thing which I thought necessary to be known concerning bones in general; and, in the second part, I have described the several bones composing the skeleton.

The bones of adults are what I principally endeavour to describe; but I have added as much of the *osteogenea* as I think serviceable in the practice of physic and surgery.

That little might be omitted of what was formerly done on this subject, I have taken all the assistance I could from books; but have never asserted any anatomical fact on their authority, without consulting nature, from which all the descriptions are made: and therefore the quotations from such books serve only to do justice to the authors who have remarked any thing in the structure of the parts that was commonly omitted, and to initiate you in the history of anatomy; which I once proposed to make complete, so far as related to this subject: but not being able to procure several books, and being sensible how many more may have never come to my knowledge, I laid aside this design, of purpose omitted many I could have inserted, and in some places I have changed an older author for a later one who has more fully or clearly described what I treated of. Besides anatomists, I have also named several other authors to confirm my reasoning by practical cases; of which it is not to be supposed my own experience could furnish a sufficient variety.

You will readily observe, that I quote no passages with a view to criticize or condemn them. This precaution of giving no offence, is very necessary in those who are sufficiently conscious of their being liable to lay themselves open to just censure; and it prevents occasions of useless wrangling; in which, generally, both parties are losers, and the public has little advantage.

In this Treatise I always make use of the most common name of each part; and have put the synonymous names to be met with in books at the foot of the page, that the reading might be smoother, and you might consult them at your leisure, to assist you in understanding different authors.

The descriptions and reasoning are here blended; without which I always

ways find young anatomists are soon disgusted with authors: Their imaginations cannot follow a long chain of descriptions, especially when they are not taught at the same time the uses which the described parts serve: Their minds must have some relaxation, by a mixture of reasoning, which never misses to strike the fancy agreeably, and raises a strong desire to understand the principles on which it depends.

The *phænomena* of diseases are all deduced in this Essay from the structure of the parts, by way of corollaries and questions; which such an anatomical work confined me to. And this method has otherwise a good effect: for when one meets with an useful proposition, and is obliged to employ a little thought to find out its solution, the impression it makes is deeper, and he acquires a fondness for it, as being in part his own discovery. My pupils have frequently assured me, that they could, with very small reflection, trace out the whole reasoning from which my conclusions were drawn. I hope their successors will also think this an agreeable manner of being instructed.

Those Gentlemen who desired I would add the lectures which I pronounce in my colleges as a commentary upon the text, where the diseases are mentioned, will, I persuade myself, excuse me for not complying with their desire, when they consider the design of this is to be a school-book, and how great the difference is between instructing youth in private and pretending to inform the public. Art. xxv. vol. v. of Medical Essays and Observations*, published in this place, is one of those lectures which I gave as a commentary on the paragraph (p. 38.) concerning the different kinds of *caries*.

In this edition, I have corrected the mistakes and obscure passages which I discovered in the former, and in some places I have made the descriptions more full and exact; aiming all I could to shun unnecessary minuteness on the one hand, and a blameable inaccuracy on the other. Whether I have hit that just medium, is what you and the public must now judge.

I am still of opinion, that figures of the bones would at any rate have been unnecessary in a book that is intended to be illustrated and explained
by

* Or No 9. of this Collection.

by the originals themselves; but would be much more so now, when my late ingenious friend Mr Cheselden, Dr Albinus, and Mr Sue *, have published such elegant ones.

You have advantageous opportunities in this place of studying all parts of Medicine, under the Professors of its different branches in the University; and of seeing the practice of Pharmacy, Surgery, and Physic, with our Surgeon-apothecaries, and in the Royal Infirmary, where the diseased poor are carefully treated. These, your interest, and I hope your inclinations, will lead you, Gentlemen, so to improve, as that they may become the happy means of your making a considerable figure in your several stations. Whatever assistance is in my power towards such a desirable event, shall be given with the greatest pleasure, by

Your humble Servant,

ALEX^R MONRO.

* *Traité d'Osteologie, traduit de l'Anglois de M. MONRO, seconde partie.*

T H E
A N A T O M Y
O F T H E
H U M A N B O N E S.

P A R T I.

Of the BONES in general.

BONES are covered by a membrane, named on that account PERIO-
STEUM *; which is so necessary to them, that we must examine its
texture and uses, before we can understand their structure.

The *periosteum*, as well as most other membranes, can be divided into
layers of fibres. The *exterior* ones, composed of the fibres of the muscles
connected to the bones, vary in their number, size, and direction; and
consequently occasion a very great difference in the thickness and strength
of the *periosteum* of different bones, and even of the different parts of the
same bone. The *internal* layer is every where nearly of a similar struc-
ture, and has its fibres in the same direction with those of the bone to
which

* Membrana circumossalis, omentum ossibus impositum.

which they are contiguous. Ought not then the name *periosteum* to be applied, strictly speaking, only to this internal layer, to which the others are joined in an uncertain manner and number?

Some authors * endeavour to prove the internal layer of fibres of the *periosteum* to be derived from the *dura mater*: For, say they, since the membrane covering the skull is plainly a production or continuation of the *dura mater*, which passes out between the *sutures*; and since there are muscles on the head, as well as in other parts, which might furnish a *periosteum*; it is needless to assign different origins to membranes which have the same texture and uses. They add further, in proof of this doctrine, that the *periosteum* extends itself along the ligaments of the articulations from one bone to another; and therefore is continued from its origin over all the bones of the body.—While anatomists were fond of the hypothesis of all membranes being derived from one or other of the two that cover the brain, a dispute of this kind might be thought of consequence: but now that the hypothesis is neglected as useless, it is needless to examine the arguments for or against it.

Except where muscles, cartilages, or ligaments, are inserted into the *periosteum*, its external surface is connected to the surrounding parts by thin cellular membranes, which can easily be stretched considerably, but shorten themselves whenever the stretching force is removed. When these membranes are cut off or broken, they collapse into such a small space, that the surface of the *periosteum* seems smooth and equal.

When we attempt to tear off the *periosteum* from bones, we see a great number of white threads produced from the membrane into them; and after a successful injection of the arteries with a red liquor, numerous vessels are not only seen on the *periosteum* †, but most of the fibres, sent from the membrane to the bone, show themselves to be vessels entering it, with the injected liquor in them; and when they are broken, by tearing off the *periosteum*, the surface of the bone is almost covered with red points.

The veins corresponding to these arteries are sometimes to be seen in subjects that die with their vessels full of blood; though such numerous
ramifications

* Havers, Osteolog. Nov. disc. 1. p. 16.

† Ruysch, epist. 5. tab. 5. fig. 1, 2.; epist. 8. tab. 9. fig. 1, 9.

ramifications of them, as of the arteries, can seldom be demonstrated, because few of them naturally contain coloured liquors, and such liquors can difficultly be injected into them. This, however, is sometimes done *.

The great sensibility of the *periosteum* in the deep-seated species of *paronychia*, in *exostoses*, *nodi*, *tophi*, and *gummata*, from a *lues venerea*, or whenever this membrane is in an inflamed state, is a sufficient proof that it is well provided with nerves, though they are perhaps too small to be traced upon it; and therefore one cannot well determine whether they are sent along with the arteries in the common way, or are derived from the tendinous fibres of the muscles expanded on the *periosteum* †.

Vessels also pass through the *periosteum* to the marrow; of which more hereafter. And frequently muscles, ligaments, or cartilages, pierce through the *periosteum*, to be inserted into the bones.

The chief uses of the *periosteum* are: 1. To allow the muscles, when they contract or are stretched, to move and slide easily upon the bones; the smooth surface of this membrane preventing any ill effects of their friction upon each other. 2. To keep in due order and to support the vessels in their passage to the bones. 3. By being firmly braced on the bones, to assist in setting limits to their increase, and to check their overgrowth. 4. To strengthen the conjunction of the bones with their *epiphyses*, ligaments, and cartilages; which are easily separated in young creatures when this membrane is taken away. 5. To afford convenient origin and insertion to several muscles which are fixed to this membrane. And, lastly, To warn us when any injury is offered to the parts it covers; which, being insensible, might otherwise be destroyed without our knowledge, or endeavouring to procure a remedy.

When the cellular substance, connecting the *periosteum* to the surrounding parts, is destroyed, these parts are fixed to that membrane, and lose the sliding motion they had upon it; as we see daily in issues, or any other tedious suppurations near a bone.—When the vessels which go from

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the

* Sue traité d'Osteologie, traduit de l'Anglois de Mr. Monro. Note in p. 9.

† See the dispute about the sensibility of this and of other membranes, in Zimmerman. Dissert. de Irritabilit.;—Act. Gotting. vol. ii.;—Haller sur la Nature Sensible et Irritable;—Whytt's Physiolog. essay 2.;—Reimar. Dissert. de Fungo Articular. § 26, 34.

the *periosteum* to the bones are broken or eroded, a collection of liquor is made between them, which produces a fordid ulcer or rotten bone. This often is the case after fractures of bones and inflammations of the *periosteum*, or after *small-pox*, *measles*, *spotted fevers*, and *erysipelas*.—Do not the disorders of the *periosteum*, coming rather along with, or soon after, the cutaneous, than other diseases, indicate some similarity of structure in the *periosteum* and skin?

The BONES are the most hard and solid parts of the body, and, as all other parts where large vessels do not enter, are generally of a white colour; only in a living creature they are blueish, which is owing to the blood in the small vessels under their surface. The less therefore, and fewer, the vessels are, and the thicker and firmer the bony surface covering the vessels is, the bones are whiter. Hence the bones of adults are whiter than those of children: and, in both young and old, the white colour of different bones, or of the several parts of the same bone, is always in proportion to their vessels and solidities; which circumstances ought to be regarded by surgeons, when they are to judge of the condition of bones laid bare.

Bones are composed of a great many *plates* *, each of which is made up of fibres or strings united by smaller fibrils †; which being irregularly disposed and interwoven with the other larger fibres, make a reticular work.—This texture is plainly seen in the bones of fœtuses, which have not their parts closely compacted; and in the bones of adults, which have been burnt, long exposed to the weather, or whose composition has been made loose by diseases.—The chinks, which are generally made according to the direction of the larger fibres, of bones that have undergone the action of fire, or of the weather, show the greater strength of these than of the fibres which connect them.—Numerous accurate observations of the different times in which exfoliations are made from the sides or ends of similar bones, might bid fair to determine what is the proportional force of cohesion in the two sorts of fibres.

The plates are said ‡ to be firmly joined to each other by a great number of *claviculi*, or small bony processes; which, rising from the inner plates,

* Squamæ, bractææ, laminæ.

† Malpigh. Anat. Plant. et Oper. Posthum.

‡ Gagliard. Anat. Ossium. nov. invent. illustrat. cap. 1. cbs. 2.

plates, pierce through some, and are fixed into the more external ones. Of these nails, four kinds, viz. the *perpendicular*, *oblique*, *beaded*, and *crooked*, have been described: but in bones fitly prepared, I could only see numerous irregular processes rising out from the plates *.

Though the exterior part of bones is composed of firm compact plates, yet they are all more or less cavernous internally. In some (*e. g.* middle thin part of the *scapula* and *os ilium*) the solid sides are brought so near, that little cavity can be seen; and in others (middle of *os humeri*, *femoris*, &c.) the cavities are so large, that such bones are generally esteemed to be hollow or fistular: But the internal spongy texture is evident in young animals; and some of it may be seen to remain in those of greatest age, when bones are cautiously opened, after they have been kept so long as to be free of the oil they contain, or after being burnt.

This spongy cavernous internal part of bones, is generally called their *cancelli* or LATTICE-WORK, and is formed in the following manner. The plates are firmly joined about the middle of the bone; but as they are extended towards its ends, the more internal plates separate from the exterior, and stretch out their fibres towards the axis of the bone, where they are interwoven with the fibres of other plates that have been sent off in the same way. Seeing the plates are thus constantly going off, the solid sides of the bones must become thinner, and the lattice-work must be thicker and stronger, towards their ends. This is evident in many of them, where the solid sides of their middle are very thick, and the *cancelli* are scarce observable: whereas at the ends, where their diameter is greatest, the solid walls or sides are not thicker than paper; and the *cancelli* are numerous, and large enough to fill up the whole space left between the sides.

The twisting and windings which these *cancelli* make, and the interstices which they leave, differ considerably in figure, number, and size; and therefore form little cells, which are as different, but communicate with each other. Some writers † minutely remark these different appearances of the *cancelli*, after they begin to separate from the plates; and from thence distinguish them into *wrinkled*, *perforated*, and *net-like*.

The *cancelli* sustain the membranous bags of the marrow which are

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stretched

* Malpigh. Oper. Posthum.

† Gagliard. Anat. Ossium, cap. 1. obs. 4, 5, 6, 7.

stretched upon them; and thereby hinder these membranous parts from being torn, or removed out of their proper places, in the violent motions and different postures which the bones are employed in. This support which the *cancelli* afford the marrow, also saves its membranes and vessels, in the lower parts of the bones, from being compressed by the weight of the marrow above.

The depressions between the fibres of the external plates of bones appear like so many furrows on their surface, into each of which the *periosteum* enters; by which the surface of contact, consequently the cohesion, between it and the bone, is considerably increased, and a greater number of vessels is sent from it into the bone than if it was a plain surface.

Both on the ridges and furrows, numerous little pits, or orifices of canals, are to be seen, by which the vessels pass to and from the bones.

After a successful injection, the arteries can be traced in their course from the pits to the plates and fibres; and in sawing, cutting, or rasping the bones of living creatures, these vessels discover themselves by the small drops of blood which then ooze out from the most solid part of the bones. But the clearest demonstration of the intimate distribution of these small arteries, is to observe the effect of such a tinging substance as can retain its colour, when swallowed, digested, and mixed with the blood of any living animal, and at the same time has particles small enough to be conveyed into the vessels of the bones; such is *rubia tinctorum*, madder-root *: for we see the gradual advances which this tincture makes from the *periosteum* into the more internal parts of the bones, and how universally the distribution of the liquors is made, the whole bony substance being tinged.

The arteries are larger near each end than at the middle of the large bones that are much moved; because they not only serve the bony plates near the ends, but pass through them to the marrow.—As animals advance in age, the arteries of the bones become less capacious; as is evident, 1. From the bones of adults having less blood in them than those of children have. 2. From many of them becoming incapable in old age of admitting the coloured powders used in injections, which easily pass in.

* Philosoph. Transact. n° 442. art. 8.; n° 443. art. 2.; n° 457. art. 4. Mem. de l'Acad. des Sciences, 1739, 1742.

in youth. And, 3. From the bones of old creatures being more difficultly tinged with madder than those of young ones.—If authors have not mistaken, the arteries of bones have sometimes become very large *.

We may conclude, from arteries being accompanied with veins so far as we can trace them in every other part of the body, that there are also veins in the bones; nay, the veins of bones can sometimes be injected, and then seen †.

The bones of a living animal are so insensible, that they can be cut, rasped, or burnt, without putting the creature to pain; and the nerves distributed in their substance cannot be shewn by dissection: from which it might be inferred, that they have no nerves distributed to them. But the general tenor of nature, which bestows nerves to all the other parts, should prevent our drawing such a conclusion. And if sensibility is a sure proof of nerves entering into the composition of any part, as it is generally allowed to be, we have sufficient evidence of nerves here in the bones: for the granulated red flesh which sprouts out from them, after an amputation of a limb, or performing the operation of the *trepan*, or after an *exfoliation*, is exquisitely sensible; and in some ulcers of bones, where the *periosteum* was all separated, the patient suffered racking pain if the bone was touched with a rough instrument, nor was he free of pain after the bone was perforated ‡.—The reason why the nerves of rigid hard bones become insensible, is, that all nerves must have a considerable degree of flexibility at the part where objects are applied, otherwise it cannot be affected by their impressions. We see this illustrated in a very common analogous case, the growth of a new nail. When the former one has supplicated off, the thin membrane which first appears is exquisitely sensible; but gradually becomes dull in its sensation, till it can be cut or scraped without causing pain, after it is formed into a hard nail.

From what has been said of the vessels of bones, it is evident, that there is a constant circulation of fluids in every part of them; and that there is a perpetual waste and renewal of the particles which compose the solid fibres of bones, as well as of other parts of the body; the addition from the fluids exceeding the waste during the growth of the bones, the re-
newal

* Diemerbroek Anat. lib. 9. cap. 1. Mery Hist. de l'Acad. des Sciences, 1704.

† Sue trad. d'Osteolog. p. 9.

‡ Nicol. Massa, lib. introd. anat. cap. 30.

newal and waste keeping pretty near *par* in adult middle age, and the waste exceeding the supply from the liquors in old age: as is demonstrable from their weight; for each bone increases in weight as a person approaches to maturity, continues of nearly the same weight till old age begins, and then becomes lighter.—The specific gravity of the solid sides, on the contrary, increases by age; for then they become more hard, compact, and dense. In consequence of this, the bones of old people are thinner and firmer in their sides, and have larger cavities, than those of young persons.

The vascular texture of bones must make them subject to *obstructions*, *ecchymoses*, *ulcers*, *gangrenes*, and most other diseases which the softer parts are affected with; and therefore there may be a greater variety of *caries* than is commonly described *.

Hence we can account for the following appearances.

Hæmorrhages from fungous flesh rising out from the most solid part of a cut bone †.

The regular alternate elevation and subsiding, or apparent pulsation, frequently to be seen in some of the cells of a carious bone.

Cells resembling *cancelli*, sometimes seen in the part of a bone which, in a natural state, is the most solid and firm ‡.

A bone as a tube, including another bone within it §.

On the internal surface of the solid parts of bones, there are orifices of canals, which pass outwards through the plates to open into other canals that are in a longitudinal direction, from which other *transverse* passages go out to terminate in other *longitudinal* canals; and this structure is continued through the whole substance of bones, both these kinds of canals becoming smaller gradually as they approach the outer surface **. —These canals are to be seen to the best advantage in a bone burnt till it is white: When it is broken transversely, the orifices of the *longitudinal* canals are in view; and when we separate the plates, the *transverse* ones are to be observed. Here, however, we are in danger of believing
both

* Edinburgh Medical Essays and Obs. vol. v. art. 25. or N° 9. of the present Collection.

† Medical Essays, vol. iv. art. 21. or N° 19. of the present Collection.

‡ Ruyfch. Thef. 8. n° 8. Thef. 10. n° 176. § Idem, ibid.

** Havers Osteolog. Nov. p. 43.

both these sorts of canals more numerous than they really are; because the holes made by the processes connecting the plates of bones have the appearance of the *transverse* *, and the passages for the blood-vessels resemble the *longitudinal* canals. I do not know how we are to keep free of error about the *transverse* canals; but think we may distinguish between the two kinds of *longitudinal* ones: for the passages of the vessels are largest near the external surface of the bone, and every transverse section of them is circular; whereas the *longitudinal canals* are largest near the *cancelli*, and their transverse sections appear to me of a flat oval figure; which may be owing to the different *momentum* of the fluids conveyed in them.—The situation of the larger longitudinal canals, and of the passages of the larger vessels, makes a bone appear more dense and compact in the middle of its solid sides, than towards its outer and inner surfaces, where it is spongy.

We see marrow contained in the larger transverse and longitudinal canals just now described; and from thence judge that it passes also into the smaller ones. The drops of oil which we discover with a microscope every where on the surface of a recent bone fractured transversely, and the oozing of oil through the most solid bones of a skeleton, which renders them greasy and yellow, are a confirmation of the use of these canals. Of what advantage this distribution of the marrow through the substance of bones is, will be mentioned when the nature and use of this animal-oil is inquired into.

Most bones have one or more large oblique canals formed through their sides, for the passage of the medullary vessels, which are to be described afterwards.

Bones exposed to a strong fire in chemical vessels, are resolved, in the same manner as the other parts of animals, into *phlegm*, *spirit*, *volatile salt*, *fetid oil*, and a black *caput mortuum*. But the proportion of these principles varies according to the age, solidities, and other circumstances of bones. Young bones yield the largest proportion of *phlegm*; spongy bones afford most oil, and solid ones give most salt and black *residuum*. Though this *residuum* can scarce be changed by the force of fire while it is in close vessels; yet when it is burnt in an open fire, the tenacious oil,

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* Morgagn. Advers. 2. animad. 25.

to which it owes its black colour, is forced away, and a white earth is left, that has little or no fixed salt in it. This earth seems to be the proper constituent solid part of bones; and the other principles give it firmness and tenacity: For the quantity of the earth is so great, that, after all the other principles are separated from a bone, its former shape and size remain*; but it is very brittle till it is moistened with water or oil, when it recovers some tenacity.—The increase of the proportion of earth in old peoples bones, is one reason of their being more brittle than those of young people are.

Let any imagine the salts and oils of bones, while in a natural state, to be of the same acrid kind with those obtained from them by the chemical analysis, it is to be observed, that these principles may be extracted from bones in the form of a very mild jelly, by boiling them in water.

The bones sustain and defend the other parts of the body.

Bones are lined within, as well as covered externally, with a membrane; which is therefore commonly called PERIOSTEUM INTERNUM.

The *internal periosteum* is an extremely fine membrane; nay, frequently it has a loose reticular texture: and therefore it is compared by some to the *arachnoid* coat of the spinal marrow. So that we cannot expect to divide it into layers as we can divide the *external periosteum*. We can, however, observe its processes entering into the transverse pores of the bones, where probably they are continued to form the immediate canals for the marrow distributed through the substance of the bones; and along with them vessels are sent, as from the external *periosteum*, into the bone†. The processes being of a very delicate texture, the adhesion of this membrane to the bone is so small, that it separates commonly more easily from the bone than from the marrow which it contains; wherefore one might call it the common membrane of the marrow, rather than by the name it now has: but whether the one or the other designation ought to be given it, is not worthy a dispute.

From the internal surface of the internal *periosteum*, a great number of thin membranes are produced; which, passing across the cavity, unite with others of the same kind, and form so many distinct bags, which communicate

* Havers Osteolog. Nov. disc. 1. p. 32.

† Winslow Exposition Anat. des Os frais, § 82, 83.

communicate with each other ; and these again are subdivided into communicating vesicular cells, in which the marrow is contained. Hence it is, that the marrow, when hardened and viewed with a microscope, appears like a cluster of small pearl ; and that the hardened marrow of bones buried long under ground, or laid some time in water, and then dried, is granulous (a). This texture is much the same with what obtains in the other cellular parts of the body, where fat is collected : only that the cells containing the marrow are smaller than those of the *tunica adiposa* or *cellulosa* elsewhere ; which probably is owing to their being inclosed in the bones, where they are not so much stretched or extended as in other parts.

The MARROW is the oily part of the blood, separated by small arteries, and deposited in these cells. Its colour and consistence may therefore vary according to the state of the vessels, and their distribution on the membranes of the cells.

The marrow, as well as the other fat of the body, chemically analyzed, yields, besides oil and water, a considerable proportion of an acid liquor, but no *alkali* (b). This may be the reason of its being less putrescent than the blood, or most other parts of animals (c) ; which is a necessary quality in a substance that is constantly exposed to a considerable degree of heat, and is more in a stagnating condition than the other liquors.

Besides the arteries, which I mentioned already (p. 36.) to be sent from the bones to the marrow, there is at least one artery for each bone ; several bones have more, whose principal use is to convey and secrete this oily matter. After these arteries have pierced the solid side of a bone, they are divided into several branches ; which soon are distributed every where on the internal *periosteum*, and afterwards spread their branches inwards on the medullary cells, and outwards through the tables of the bone.

The blood, which remains after the secretion of the marrow, is returned by proper veins, which are collected from the membranes into one or

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two

(a) Ruysch Thesaur. 9. no 2. et Advers. dec. 111. obs. 9.

(b) Grutzmacher Dissert. de Ossium Medulla. Haller Element. Physiolog. lib. 4. sect. 4.

(c) Pringle Append. to Camp-diseases, exper. 47.

two large trunks, to pass out at the same holes or passages at which the artery or arteries enter.

The general rule of the small vessels decreasing in their capacities as animals advance in age, to which many phenomena in the animal œconomy are owing, obtains here: for though the trunks of the medullary vessels enlarge as animals turn older, yet the small branches become smaller; as is evident from injections, which cannot be made to pass near so far in these vessels of adults as of children. Hence the marrow is bloody in children, oily and balmy in middle age, and thin and watery in old people.

By experiments made on the marrow, when bones of living animals are opened or cut through (*a*), and from the racking pain with which suppurations within bones are frequently attended, we have sufficient proof that the membranes here are sensible, and consequently have nerves distributed to them. Hippocrates (*b*) might therefore say justly, that a wound penetrating into the cavity of a bone may produce a *delirium*.

The vessels of the marrow, wrapped up in one common coat from the *periosteum*, pass through the bones by proper canals; the most considerable of which are about the middle of each bone, and are very oblique. Sometimes these vessels continue at a little distance in their passage, when the canal is divided by a small bony partition or two.

From the structure of the contents of the bones, we may judge how these parts, as well as others, may be subject to oedema, phlegmon, erysipelas, scirrhus, &c.; and may thence be led to a cure of each, before the common consequence, putrefaction, takes place, and frequently occasions the loss of the limb, if not of the patient.

The marrow is of very considerable use to the bones; for by entering their transverse canals, and passing from them into the longitudinal ones, it is communicated to all the plates, to soften and connect their fibres; whereby they are preserved from becoming too brittle; as we see they do in burnt bones, or those long exposed to the air; in people labouring under old age, pox, or scurvy. In all which cases, the oil is either in too little quantity, or has its natural good qualities changed for worse ones.

Besides this advantage which the substance of bones has from the marrow,

(*a*) Du Verney, Memoires de l'Acad. des Sciences, 1760.

(*b*) Aphorism. § 7. aph. 24.

row, their articulations are said * to receive no less benefit from it: for it is thought that the marrow passes into the articular cavities through the holes which are in the bones near the large joints. And as a proof of this, it is alleged, that butchers, upon seeing the greater or lesser quantity of marrow in the bones of cows, can tell whether they have travelled far or little before they were slaughtered.

When the marrow, after having served the uses mentioned, is reassumed into the mass of blood, (as it is continually, in common with all other secreted liquors that have not passages formed for conveying them out of the body), it corrects the too great acrimony communicated to the saline particles of our fluids by their circulation and heat; in the same manner as lixivial salts are blunted by oil in making soap. Hence, in acute diseases, the marrow, as well as the other fat of the body, is quickly wasted, but must be immediately supplied by liquors from the vessels; seeing the cells within the bones, which have no assistance to their contraction from the pressure of the atmosphere, cannot collapse, as the *tela cellularis* under the skin does when the liquor in its cells is absorbed; the bones therefore are always full.

Since it is the nature of all oil to become thin and rancid when exposed long to heat, and bones have much oil in their firm hard substance, we may know why an ungrateful smell, and dark-coloured thin *ichor*, proceed more from corrupted bones than from other parts of the body; and we can understand the reason of the changes of colour which bones undergo, according to their different degrees of mortification. Hence likewise we may learn the cause of a *spina ventosa*, and of the difficulty of curing all *caries* of bones proceeding from an obstruction and consequent putrefaction of the marrow; and of the quick pulse, thirst, and *hectic paroxysms*, so often attending these diseases. These *phænomena* also teach us the reason of the fatal *prognosis* taken from black fetid urine in fevers.

Though bones so far agree in their structure and annexed parts, yet we may observe a considerable difference among them in their magnitude, figure, situation, substance, connection, uses, &c. From which

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authors

* Joan de Muralto Vade-mecum Anat. exercit. 5. § 3. Havers Osteolog. Nov. disc. 3. p. 179.

authors have taken occasion to distinguish them into as many classes as they could enumerate of these different circumstances. But these being obvious to every person that looks on bones, I shall only mention one of them, which comprehends very near the whole bones of the body, and at the same time leads us to examine the most considerable variety that is to be found in the disposition of their constituent parts, and in their uses. It is this, that some bones are *broad* and *flat*, while others are *long* and *round*.

The *broad* bones have thin sides, by the plates being soon and equally sent off to form the lattice-work; which therefore is thicker, and nearly of an equal form all through. By this structure, they are well adapted to their uses, of affording a large enough surface for the muscles to rise from, and move upon, and of defending sufficiently the parts which they inclose.

The *round* bones have thick strong walls in the middle, and become very thin towards their ends: which is owing to very few plates separating at their middle; where, on that account, the *cancelli* are so fine and small, that they are not taken notice of. But such bones are said to have a large reservoir of oil in this place. Towards their ends, the lattice-work becomes very thick, and rather more complete than in the other sort of bones. These round bones having strong forces naturally applied to them, and being otherwise exposed to violent injuries, have need of a cylindrical figure to resist external pressure, and of a considerable quantity of oil to preserve them from becoming too brittle. Besides which, they are advantageously provided with thick sides towards their middle, where the greatest forces are applied to injure them; while their hollowness increases their diameter, and consequently their strength to resist forces applied to break them transversely *. Thus, for instance, in estimating the proportional resistance of two cylindrical bones of unequal diameters, but consisting of an equal number of similar fibres uniformly disposed round each, it is plain,

1. That the absolute force of these two bones is equal, because they consist of equal numbers of similar fibres.

2. That the absolute forces of all the fibres in each bone have the same effect

* Galilei Mechanic. dialog. 2.

effect in resisting any power applied to break them, as if the sum of all their forces was united in the respective centres of the transverse sections where the fractures are to be made: for, by hypothesis, the fibres being uniformly disposed in each, there is not any fibre in either bone that has not a corresponding fibre, the sum of both whose distances from the axis of revolution (about which all the parts of the bone must revolve in breaking) is equal to two semidiameters of the bone: consequently each fibre, and all the fibres, may be regarded as resisting at the distance of one semidiameter or *radius* from this axis, that is, in the centre.

3. Since the united force of all the fibres is to be regarded as resisting at a distance from the centre of motion equal to the semidiameter, it follows, that the total resistance of all these fibres, or the strength of the bone, is proportional to its semidiameter, and consequently to its diameter.

I have here taken for an example one of the most simple cases for calculating the proportional forces of bones: but, was it not too foreign to the present design; it might be universally demonstrated, that of whatever figure bones are, and in whatever manner their fibres are disposed, their strength must always be in a *ratio*, compounded of the area of their transverse sections, or of their quantity of bony matter, and of the distance of the centre of gravity of these sections from the centre of motion or fulcrum on which the bone is supposed to be broken *.

Since therefore the strength of bones depends on their number of fibres, or quantity of matter, and the largeness of their diameters, one may conclude, that the part of a bone formerly fractured, and reunited by a *callus*, must be stronger than it was before the fracture happened; because both these advantages are obtained by a *callus*: which is a wise provision, since bones are never set in such a good direction as they were naturally of; and then, wherever a *callus* is formed, there is such an obstruction of the vessels, that if the bone was again broken in the same place, the *ossific* matter could not so easily be conveyed to reunite it. This *callus* may indeed, for want of compression, be allowed to form into a
spongy

* See the demonstration of this theorem by Dr. Porterfield, in the Edinburgh Medical Essays, vol. i. art. 10.

spongy cellular substance (*a*); but, even in this case, the strength of the bone is here increased by one or both the causes above-mentioned.

Many bones have protuberances, or *processes* (*b*), rising out from them. If a *process* stands out in a roundish ball, it is called *caput*, or *head*.—If the head is flattened, it obtains the appellation of *condyle*.—A rough, unequal protuberance, is called *tuberosity*.—When a *process* rises narrow, and then becomes large, the narrow or small part is named *cervix*, or *neck*.—Long ridges of bones are called *spines*.—Such processes as terminate in a sharp point, have the general name of *coronæ* (*c*), or *coronoid*, bestowed on them; though most of them receive particular names from the resemblance they have, or are imagined to have, to other substances, *e. g.* *mastoid*, *styloid*, *anchoroid*, *coracoid*, *spinal*, &c.—Such processes as form brims of cavities, are called *supercilia* (*d*).

Processes serve for the advantageous origin and insertion of muscles, and render the articulations firm and stable.

Before leaving this subject, we must remark, that much the greater number of what are called processes in adult bones, discover themselves in children to be *epiphyses*, or distinct bones, which are afterwards united to the other parts; such are the *styloid* processes of the temporal bones, processes of the *vertebræ*, *trochanters* of the thigh, &c. However, as I design to insist chiefly on the description of the adult skeleton, in which the union of these parts is so intimate that scarce any vestige remains of their former separation, I shall retain the common appellation of *apophyse*, or process, to all such protuberances; but shall remark the principal ones that have no just title to this name, when they occur in the description of particular bones.

On the surfaces of a great many of the bones, there are cavities or depressions. If these are deep, with large brims, authors name them *cotylæ* (*e*). If they are superficial, they obtain the designation of *glenæ*, or *glenoid*.—These general classes are again divided into several *species*. Of which, *pits* are small roundish channels sunk perpendicularly into the bone:

(*a*) Ruysch Thesaur. 8. n. 49. Mus. Anat. thec. B. reposit. 2. n. 2.

(*b*) Απορυσσεις, εκρυσεις, εξοχη, προβολη, προβληµα, excessus, explanatio, tuberculum, gibbus, eminentia, productio, extuberantia, projectura, enascentia.

(*c*) Rostra, glandes.

(*d*) Τρυεις, στρουεις, αµβονεις, χειλη. Labra.

(*e*) Κοτυλιδες, οξυβαγοι, acetabula, pixides, buccellæ.

bone:—*Furrows* are long narrow canals, formed in the surface;—*notches*, or *notches*, small breaches in the bone;—*sinuosities*, broad, but superficial, depressions without brims;—*fossæ*, large deep cavities, which are not equally surrounded by high brims;—*sinuses*, large cavities within the substance of the bones, with small apertures;—*foramina*, or holes, canals that pierce quite through the substance of the bones.—When this last sort of cavity is extended any long way within a bone, the middle part retains the name of *canal*, and its ends are called *holes*.

The cavities allow the heads of bones to play in them; they lodge and defend other parts; they afford safe passage to vessels, muscles, &c. To mention more would engage us too much in the history of particular bones, which more properly belongs to the demonstration of the *skeleton*, where we shall have occasion to observe these several species of cavities.

To far the greater number of bones, whose ends are not joined to other bones by an immoveable articulation, there are smaller ones annexed, which afterwards become scarce distinguishable from the substance of the bone itself. These are called *epiphyses*, or *appendices* (a.) Some bones have one, others have two, three, or four of these *appendices* annexed by the means of cartilages, which are of a considerable thickness in children, but by age became thinner; the ossification proceeding from the end of the bone on one side, and from the *epiphyses* on the other, till at last, in adults, the place of their conjunction can scarcely be seen on the external surface, and it is only sometimes that we can then see any mark of distinction in the *cancelli* (b).

Several processes (e. g. *trochanters* of the thigh, *spine* of the *scapula*, &c.) have *epiphyses*; and processes frequently rise out from *epiphyses*; for example, at the lower end of the *femur*, *ulna*, *tibia*, &c. (c).

The *epiphyses* are united chiefly to such bones as are destined for frequent and violent motion; and for this purpose they are wisely framed of a larger diameter than the bone they belong to: for by this means the surface of contact between the two bones of any articulation being increased, their conjunction becomes firmer, and the muscles inserted into them:

(a) *Applantatio, additamentum, adnascencia, adnexum, perone.*

(b) Winslow, *Exposition Anatomique de Corps Humain, traité des os secs*, § 116.

(c) Vesal. de Human. Corp. Fabrica, lib. 1. cap. 3.

them act with greater force, by reason of their axes being further removed from the centre of motion. These advantages might indeed have been obtained by the expansion of the end of the bone itself to a thickness equal to that of the *epiphyses*; but then the constant separation of new plates to form so wide a cellular structure, must have left the solid sides of the bones so thin, as to yield easily, either to the action of the muscles fixed to them and passing over them, to the weight several of them are obliged to support, or to the application of any other external force.

Several anatomists (*a*) thought that the *epiphyses* serve other purposes; such as, securing the ligaments of the articulations which rise out from between the bones and them: for as soon as these parts are intimately joined, the ligaments insinuated betwixt them must have a much stronger connection than they could have to the smooth surface of the bones. Such an interception of the ligament between the body of the bone and its *epiphysē* is not to be seen: but as at this place the bone remains longer soft than any where else, and the adhesion of the *periosteum* and of ligaments to bones is always stronger in proportion to the bones being nearest to the consistence of those parts, which is, being softest; the opinion of these writers concerning the stronger connection of the ligaments where the bones and *epiphyses* join, is not without some foundation.

Possibly, too, by the fibres of *epiphyses* not extending themselves so longitudinally as those of the bones, there may be less chance of the former running into each other than of the latter.

The softness of the ends of bones may be of some advantage in the womb, and at birth; after which the ossification begins, at different points, to form *epiphyses*, before the ossification can extend from the middle to the ends of the bones (*b*).

However solid and compact adult bones are, yet they were once cartilages, membranes, nay, a mere jelly. This needs no further proof than repeated observations of *embryos* when dissected: And how much more tender must the bones be before that time, when neither knife nor eye is
capable

(*a*) Columb. de Re Anatomica, lib. 1. cap. 2. — Fallop. Expof. de Ossibus, cap. 11.

(*b*) Haller de Studio Medic. p. 267.

capable to discover the least rudiments of them? By degrees they become more solid, then assume the nature of gristles, and at last ossify; the cohesion of their plates and fibres always increasing in proportion to their increased solidities; as is evident from the time necessary to unravel the texture of bones of people of different ages, or of dense and of spongy bones, or of the different parts of the same bone, and from the more tedious exfoliations of the bones of adults than of children.

After any part of a bone is fully ossified, its fibres are extended little more in length at that part, though they increase there in thickness, and though their softer parts continue to become longer (*a*).

As the solidity of bones increases, their *periosteum* more easily separates from them. When bones are membranous, the *periosteum* and they cannot be distinguished; they appear to be the same substance. When they are cartilages, their membrane adheres so firmly to them, that it is difficult to separate it from them. Where the rigid bony fibres are, the *periosteum* is easily taken off.—Is the similarity of structure and consequent greater attraction of the membrane and substance it incloses, while they are both flexible, the cause of their greater adhesion? or is it owing to the vessels that go from the one to the other being then larger? or do both these causes combine to produce this effect? Or is the membrane or cartilage, which becomes bone afterwards, to be considered as the same substance with the *periosteum* (*b*)? and must all these plates of bones be therefore said to be layers of the *periosteum* hardened (*c*)?

The ossification of bones depends principally on their vessels being so disposed, and of such diameters, as to separate a liquor, which may easily turn into a bony substance when it is deprived of its thinner parts; as seems plain from the observation of the callous matter separated after fractures and ulcers, where part of the bone is taken out: For, in these cases, the vessels extending themselves, and the liquors added to them, are gradually formed into granulated flesh; which fills up all the space where the bone is taken from, then hardens, till it becomes as firm as any other part of the bone. This happens frequently, even when

G

the

(*a*) Hales's Vegetable Statics, p. 293.—Du Hamel, Memoires de l'Acad. des Sciences, 1742.

(*b*) Memoires de l'Acad. des Sciences, 1744.

(*c*) Memoires de l'Acad. des Sciences, 1743.

the ends of the diseased bone are at a considerable distance from each other (*a*).

The induration of bones is also greatly assisted by their being exposed, more than any other parts, to the strong pressure of the great weights they support, to the violent contraction of the muscles fixed to them, and to the force of the parts they contain, which endeavour to make way for their own further growth. By all this pressing force, the solid fibres and vessels of bones are thrust closer, and such particles of the fluids conveyed in these vessels as are fit to be united to the fibres are sooner and more firmly incorporated with them, while the remaining fluids are forcibly driven out by the veins, to be mixed with the mass of blood. In consequence of this, the vessels gradually diminish as the bones harden. From which, again, we can understand one reason why the bones of young animals sooner reunite after a fracture than those of old, and why cattle that are put too soon to hard labour seldom are of such large size as others of the same brood who are longer kept from labour.

That the ossifying of bones greatly depends on pressure, seems to be evinced from the frequent examples we meet with of other parts turning bony, when long exposed to the pressing force of the surrounding parts, or when they are subjected to the like circumstances by their own frequent and violent contraction. Witness the bones found frequently near the base of the heart in some old men (*b*), and in several other creatures. Nay, the muscular substance of the heart has been ossified in such (*c*), and the arteries of old men often become bony.—The cartilages of the *larynx* are generally ossified in adults.—In beasts of burden, the cartilages between the *vertebræ* of the back very often change into complete bones; and, being intimately united with the *vertebræ*, the whole appears one continued bone:—Nor is the *periosteum* exempted from such an induration (*d*.)

To

(*a*) Hildan. de Vuln. Graviss. — Med. Essays, vol. i. art. 23. — Job a Meckren, obs. 69. — Mem. de l'Acad. des Sciences, 1742. — See a collection of such cases in Boehmer de *Ossium Callo*.

(*b*) Riolan. Comment. de Ossibus, cap. 32. — Bartholin. Hist. Medic. cent. 1. hist. 50. — Ibid. cent. 2. hist. 45.

(*c*) Cheselden's Anatomy, book 1. introd. — Garengot, Hist. de l'Acad. des Sciences, 1726.

(*d*) Peyer. Ephemerid. German. decur. 2. ann. 7. observ. 205.

To confirm this argument still farther, we may observe, that bones begin their ossification at the places where they are most exposed to these causes; *viz.* in the cylindrical bones from a middle ring, and in the broad ones, at or near their centre, from one or more distinct points. The reason of which is, that these parts are contiguous to the bellies of the muscles annexed to the bones, where the swelling of these moving powers is greatest. What the effects of this may be, let any judge, who view some of the bones, as the *scapula* and *ossa ilium*, which are covered with muscles on each side; how compact and thin they are in adults, where the bellies of the muscles were lodged; whereas in children they are thicker. But this being the middle part of these bones, where the greatest number of fibres is, this particular place would have been much thicker in adults, had not this forcible cause been applied, which has not had such effects in children whose muscles have not been much exercised. — Besides, if we allow that all the parts of a bone are equally increased by the constant supply of new particles, each fibre, and every particle of a fibre, endeavours to make way for its own growth, by pushing the one next to it; and consequently by far the greatest pressure is on the middle, to make the particles firm, and therefore to begin their ossification there. Lastly, the pulsation of the medullary arteries, which enter the bones near to this middle part, may, as authors have alleged, contribute perhaps somewhat to this induration.

From the effects of pressure only it is that we can account for the bones of old people having their sides much thinner, yet more dense and solid, while the cavities are much larger than in those of young people; and for the prints of muscles, vessels, &c. being so much more strongly marked on the surfaces of the former than of the latter, if they belong to people of near the same condition in life. — Pressure must likewise be the cause which, in people of equal ages, makes these prints stronger in the bones of those who had much labour and exercise, than they are in people who have led an indolent inactive life.

Perhaps both the causes of ossification above-mentioned may be assisted by the nature of the climate people live in, and the food they use. Whence, in hot countries, the inhabitants sooner come to their height of stature than in the northerly cold regions: And thence seems to have

arisen the common practice among the ladies, of making puppies drink brandy or spirit of wine, and of bathing them in these liquors, to prevent their growing big. Nay, it has been observed, that much use of such spirits has occasioned parts, naturally soft, to petrify in some, and to ossify in other people of no great age (*a*).

From the foregoing account of the structure of bones, and of their ossification, we may understand the reasons of the following phenomena.

How the natural colour of bones may be changed by some sorts of food (*b*).

Why the bones of some people are so long in hardening, and in others never completely indurate.

Why, in such whose ossification is slow, the bones are generally thicker in proportion to their lengths, especially at their ends; as in the *rickets*.

How hard firm bones have become soft and pliable by diseases (*c*).

Why, in some diseases, *epiphyses* separate from bones (*d*), and the ends of fractured bones come asunder many years after their fractures appeared to be cured (*e*).

How bones may waste and diminish (*f*).

How bones may become solid all through, without any appearance of *cancelli* (*g*).

How *nodes*, *tophi*, and *exostoses*, happen after the erosion of the external plates of bones in the *lues venerea*, *scurvy*, *rheumatism*, and *gout*.

How

(*a*) Littre, Histoire de l'Acad. des Sciences, 1706. — Geoffroy, Memoires de l'Acad. des Sciences, 1706.

(*b*) Philosoph. Transact. n° 442. art. 8. n° 443. art. 2. n° 457. art. 4.; — Mem. de l'Acad. des Sciences, 1739, 1742.

(*c*) Histoire de l'Acad. des Sciences, 1700. — Mem. 1722. — Gagliardi, Anatom. Ossium, cap. 2. observ. 3. — Ephem. Germ. decur. 1. ann. 1. obs. 37. et schol. decur. 2. ann. 7. obs. 212, 235. decur. 3. ann. 2. obs. 3. — Philosoph. Transf. n° 470. § 3.; Ibid. vol. xlviii. § 4. and 44.

(*d*) Memoires de l'Acad. des Sciences, 1699. — Diemerbroek, Anat. lib. 9. cap. 19. — Cowper's Anat. Explic. tab. 96. fig. 1.

(*e*) Anson's Voyage.

(*f*) Cheselden's Anat. book 1. introd. — Hist. de l'Acad. des Sciences, 1700.

(*g*) Ruysch. Thesaur. 2. arc. 5. thes. 3. loc. 1. n° 5. thes. 9. n° 2. not. 3. — Boehmer de Callo Ossium.

How bones exfoliate by the rising of granulated flesh from their surface.

How, and from what, *callus* is formed after a fracture (*a*).

Why *callus* appears to be rather the continued substance of the *periosteum* than of the bone, while it remains soft and flexible; but seems continued with the bone after it ossifies (*b*).

Why *callus* is sensible while it is soft, but becomes insensible when it hardens.

What occasions sometimes such difficulty in curing fractured bones; or why they never reunite, though they are reduced, and all proper means towards a cure are used (*c*). Are the bones of women with child more tedious in reuniting than those of other people (*d*).

Why *calluses*, after fractures, are sometimes very thick and protuberant.

What difference there ought to be in the application of bandages to fractures of the bones of old and of young patients.

How bones, remaining long unreduced after a luxation, may have their form so changed, as to make their reduction very difficult, if not impossible (*e*).

Whoever is desirous to know, in what time and order each bone and its several parts begin to assume a bony nature, let him consult *Kerckringius* (*f*), who gives us the delineations of abortions from three days after conception, and traces the ossification of the bones from three weeks and a month till the time of the birth. To whom should be added *Coiterus* (*g*), and *Eyffonius* (*h*). An account of this subject might also be collected out of *Ruyfch's* works, where some of the mistakes committed by the former authors

(*a*) Memoires de l'Acad. des Sciences, 1741.—Dehtleef de Ossium Callo.

(*b*) Mem. de l'Acad. 1741.

(*c*) Meckren Observ. Medico-chirurg. obs. 71.—Ruyfch. Advers. dec. 2. § 2.; Obser. Anat.-chir. obs. 4.—Van Swieten in Boerhaave Aphor. § 354.

(*d*) Hildan. centur. 5. obs. 87. et cent. 6. obs. 68.—Philosoph. Transact. n^o 494. § 21.

(*e*) Saltzman, Obs. Decur. obs. 6. —Memoires de l'Acad. de Chirurgie, tom. ii. p. 155.. Boehmer Instit. Osteolog. § 596.

(*f*) Anthropograph. Ichnograph. et Osteogenea Fœtuum

(*g*) De Ossibus Fœtûs Abortivi.

(*h*) De Ossibus Infant. cognoscend. et curand.

authors are corrected; and several more particulars, to make the history of the *osteogenea* more accurate, have since been added by *Nesbitt* (a) and *Albinus* (b).

I must refer to the authors now quoted for the more curious part of the human osteogeny; not having preparations enough to give such a full history of it as is done by them. But I shall endeavour to explain the more useful and necessary parts of the osteogeny, by subjoining to the description of each bone of an adult, its condition in ripe children, that is, in such as are born at the ordinary time; and shall point out what parts of each are afterwards joined in form of *epiphyses*. This, with the following general rules, seem to me sufficient for understanding what of this subject is necessary in the practice of physic and surgery.

1. Wherever I mention any parts being cartilaginous, or their being still separable from the other parts of the bone to which they belong, I would be understood to hint, that, about seven or eight years of age, such parts are ossified and united to their proper bones, unless when it is said that they are afterwards formed into *epiphyses*.

2. Such as become *epiphyses*, are generally ossified at seven or eight years of age; but being for the most part moistened by *synovia*, their external surface is still somewhat cartilaginous, and they are not yet united to their bones.

3. At eighteen or twenty years of age, the *epiphyses* are entirely ossified, and have blended their fibres so with the body of the bone, as to make them inseparable without violence.

The knowledge of this part of the osteogeny I think necessary, to prevent dangerous mistakes in the cure of several diseases. As, for example, without this knowledge, the separation of an *epiphyse* might be mistaken for a fracture or luxation; the interstice of two parts of a bone not yet joined, might be judged to be a fissure; a *diastasis*, or separation of such disjointed pieces of a bone, might be thought a fracture; the protrusion of one piece, or its overlapping any other, could be mistaken for an excrescence or *exostosis*. Such errors about the nature of a disease would give one very different indications of cure, from what he would have
if

(a) Human Osteogeny explained.

(b) *Icones Ossium Fœtus Humani; accedit, Osteogenæ brevis historia.*

if he really understood his patient's case. And very often the knowledge of the different inequalities on the surfaces of bones, must direct us in the execution of what is proper to be done to cure several of their diseases.

Having thus considered the bones when single, we ought next to show the different manner of their conjunctions (*a*). To express these, anatomists have contrived a great number of technical terms; about the meaning, propriety, and classing of which, there has unluckily been variety of opinions. Some of these terms it is necessary to retain, since they serve to express the various circumstances of the articulations, and to understand the writers on this subject.

The ARTICULATIONS are most commonly divided into three classes, viz. *symphysis*, *synarthrosis*, and *diarthrosis*.

Symphysis, which properly signifies the concretion or growing together of parts, when used to express the articulations of bones, does not seem to comprehend, under the meaning generally given to it, any thing relating to the form or motion of the conjoined bones; but by it most authors only denote the bones to be connected by some other substance: and as there are different substances which serve this purpose, therefore they divide it into the three following species.

1. *Synchondrosis* (*b*), when a cartilage is the connecting substance. Thus the ribs are joined to the *sternum*; thus the bodies of the *vertebræ* are connected to each other, as are likewise the *ossa pubis*.

2. *Synneurosis*, or *syndesmosis*, when ligaments are the connecting bodies, as they are in all the moveable articulations.

3. *Syffurosis*, when muscles are stretched from one bone to another, as they must be where there are moveable joints.

The *second* class of articulations, the *synarthrosis*, which is said to be the general term by which the immoveable conjunction of bones is expressed, is divided into three kinds.

1. The *suture* (*c*) is that articulation where two bones are mutually indented.

(*a*) Συνταξις, συνδισις, συμβολη, ομιλια, compositio, connexio, articulatio, conjunctio, nodus, commissura, structura, compages.

(*b*) Amphiarthrosis.

(*c*) 'Ραφη.

dented into each other, or as if they were sewed together; and is formed by the fibres of two bones meeting while they are yet flexible and yielding, and have not come to their full extent of growth: so that they mutually force into the interstices of each other, till, meeting with such resistance as they are not able to overcome, they are stopped from sprouting out farther, or are reflected; and therefore these indentations are very different both in figure and magnitude. Thus the bones of the head are joined; thus *epiphyses* are joined to the bones, before their full connection and union with them.

Under this title of *future*, the *harmonia* of the ancients may be comprehended; scarce any unmoved bones being joined by plain surfaces (*a*.)

2. *Gomphosis* (*b*) is the fixing one bone into another, as a nail is fixed in a board. Thus the teeth are secured in their sockets.

3. *Schindylesis*, or *ploughing* (*c*), when a thin *lamella* of one bone is received into a long narrow furrow of another. Thus the *processus azygos* of the *sphenoid*, and the nasal process of the *ethmoid* bone, are received by the *vomer*.

The *third* class, or *diarthrosis* (*d*), is the articulation where the bones are so loosely connected as to allow large motion. This is subdivided into three kinds.

The first is *enarthrosis*, or the ball and socket, when a large head is received into a deep cavity; as the head of the *os femoris* is into the *acetabulum coxendicis*.

The second is *arthrodia*, when a round head is received into a superficial cavity; as in the articulation of the arm-bone and *scapula*. These two species of *diarthrosis* allow motion to all sides.

The third is *ginglimus* (*e*), which properly signifies the hinge of a door or window: in it the parts of the bones mutually receive and are received, and allow of motion two ways. Workmen call it *charnal*.

The *ginglimus* is generally divided into three kinds; to which some (*f*) give the names of *contiguous* (*g*), *distant* (*h*), and *compound* (*i*.)

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|---|------------------------|------------------------------|
| (a) Vesal. Obser. Fallop. Examen. | (b) Conclavatio. | (c) Keil, Anat. cap. 5. § 3. |
| (d) <i>Ἀπαρθρωσις</i> , dearticulatio, abarticulatio. | (e) Articulatio Mutua. | |
| (f) Baker, Curs. Osteolog. demonstr. 1. | (g) Proximus. | (h) Longus. |
| (i) Compositus. | | |

The first kind of *ginglimus* is, when a bone has several protuberances and cavities, which answer to as many cavities and processes of the other bone with which it is articulated; as in the conjunction of the *femur* with the *tibia*.

The second species is, when a bone receives another at one end, and is received by the same bone at the other end; as in the *radius* and *ulna*.

The last sort is, when a bone receives another, and is received by a third; as in the oblique processes of the *vertebræ*.

When I first mentioned the articulations of bones, I said there were different opinions concerning the use of their technical names: *e. g.* It has been said, That *symphysis* should be the name for the immoveable articulations, and *synarthrosis* should be understood to be the conjunction of bones by some connecting *medium*. Those who have taken *symphysis* in the sense I did, of its expressing the conjunction of bones with a connecting substance, have disagreed in their definition of it; some inserting, and others leaving out, its allowing motion. Where they have agreed in their definition, they have not been of the same mind concerning the species of it: for several think the *symparcofis* and *syndesmosis* applicable to so many joints, which are universally allowed to be classed under the *diarthrosis*, that it must create confusion to name them by any species of the *symphysis*. Few keep to such a general definition of the *synchondrosis* as I have done; and, whether they determine it to allow no motion, or an obscure or a manifest one, bring themselves into difficulties, because there are examples of all these three kinds. Some again, by too nicely distinguishing obscure and manifest motions of bones, have blended the *synarthrosis* and *diarthrosis*, and from thence have branched out the different compound species of articulations that may be formed of them, so far, that they could find no examples in the body to illustrate them by. It would be tedious to enumerate more of the jarring opinions; and it would be far more so to give a detail of the arguments used by the disputants. It is sufficient for my purpose, that it is understood in what sense I take these technical terms; which I do in the following manner.

When I mention the *symphysis* or *synarthrosis*, or any species of them, I shall always understand them according to the explication already given of them. But though the preceding account of the *diarthrosis*, or articu-

lation of moveable bones, has been almost universally received; yet seeing it does not comprehend all the moveable articulations of the body, and one of its species does not answer to any notion we can have of the conjunction of two bones, I must beg leave to change the definitions and kinds of these joints.

I would call *diarthrosis* that conjunction of bones, whereby they are fitted for motion, being each covered with a smooth cartilage, connected by one or more common ligaments, and lubricated with liquor at the conjoined parts. In which definition, I have no regard to the quantity of motion which they really do perform; the motion being often confined or enlarged by some other cause not immediately depending on the frame of the two surfaces of the bones forming the particular joint which then is considered.

The first species of the *diarthrosis*, viz. the *enarthrosis*, or ball and socket, I would define, more generally than above, That articulation where a round head of one bone is received into a cavity of another; and consequently, without some foreign impediment, is capable of motion to all sides. Examples of this kind are to be seen in the articulation of the thigh-bone and *ossa innominata*; arm-bone and *scapula*; *astragalus* and *os naviculare*; *magnum* of the wrist, with the *scaphoides* and *lunare*; first bone of the thumb with the second, &c.

The second sort, or the *arthrodia*, differing from the *enarthrosis*, in the preceding account, only in the cavity's being more superficial; which makes no essential difference, especially that, in the recent subject, cartilages or ligaments supply the deficiency of bone, ought, in my opinion, to be called with *Vesalius* (a), That articulation of two bones adapted for motion, where it is not at first sight obvious which of the two has the head or cavity, or where they are joined by plain surfaces, or nearly so; such is the conjunction of the *clavicle* with the *scapula*; *ossa cuneiformia* with the *os naviculare*; *metatarsal* bones with the *ossa cuneiformia*, &c. From the nature of this sort of joint, it is plain, that very great motion cannot be allowed, without the bones going farther out of their natural situation than is convenient or safe.

Ginglimus, I would reckon that articulation by the form of which the
motion

(a) De Corp. Human. Fabrica, lib. 1. cap. 4.

motion of the joined bones must be chiefly confined to two directions, which hinges of doors are.

The first species of this is the *trochoides*, when one bone turns on another, as a wheel does on its axis. Thus the first *vertebra* of the neck moves on the tooth-like process of the second. This is the most proper kind of *ginglimus*.

The second species should be esteemed that articulation where several prominent and hollow surfaces of two bones move on each other within the same common ligament; as in the knee, elbow, &c.

The third sort of *ginglimus* is, when two bones are articulated to each other at different parts, with a distinct *apparatus* of the motory machines at each: such is the articulation of the *os occipitis* with the first *vertebra* of the neck; of any two contiguous *vertebræ*, by their oblique processes; of the ribs with the bodies and transverse processes of the *vertebræ*; of the *radius* with the *ulna*, *tibia* with the *fibula*, *astragalus* with the *calcaneum*, &c.

I would entirely throw out what is commonly called the third kind of *ginglimus*: For in examining the conjunction of a bone with two others, as in the common example of a *vertebra* joined with the one above and below, the connection of the middle one with each of the other two ought to be considered separately; otherwise we might with the same propriety esteem the articulations that the long bones, the *femur*, *tibia*, *humerus*, &c. have at their different ends, as one articulation; which is absurd.

If the moveable bones are not connected and kept firm by some strong substance, they would be luxated at every motion of the joints; and if their hard rough unequal surfaces were to play on each other, their motion would not only be difficult, but the loss of substance from attrition would be great. Therefore *ligaments* are made to obviate the *first*, and *cartilages* to prevent the other inconveniency. But because ligaments and cartilages turn rigid, inflexible, and rough, unless they are kept moist, a sufficient quantity of proper liquors is supplied for their lubrication, and to preserve them in a flexible state. Seeing then these parts are so necessary to the articulations, I shall next consider their structure,

situation, and uses, so far as they are subservient to the bones and their motions.

LIGAMENTS (*a*) are white flexible bodies, thicker and firmer than membranes, and not so hard or firm as cartilages, without any remarkable cavity in their substance, difficultly stretched, and with little elasticity; serving to connect one part to another, or to prevent the parts to which they are fixed from being removed out of that situation which is useful and safe.

After maceration in water, the ligaments can easily be divided; and each ligamentous layer appears composed of fibres, the largest of which are disposed in a longitudinal direction.

The *arteries* of ligaments are very conspicuous after a tolerable injection; and the larger trunks of their veins are sometimes to be seen full of blood.

Such ligaments as form the sides of cavities, have numerous orifices of their arteries opening upon their internal surface, which keep it always moist. If we rub off that moisture, and then press the ligament, we can see the liquor oozing out from small pores; and we can force thin liquors injected by the arteries into the cavities formed by ligaments.

These exhalent arteries must have corresponding absorbent *veins*, otherwise the cavities would soon be too full of liquor.

Ligaments, then, must be subject to the diseases common to other parts where there is a circulation of fluids; allowance always being made for the size of vessels, nature of the fluids, and firmness of the texture of each part.

Authors generally say, that ligaments are insensible; and consequently it may be inferred, that they have no nerves bestowed on them. But the violent racking pain felt on the least motion of a joint labouring under a *rheumatism*, the seat of which disease seems often to be in the ligaments, and the insufferable torture occasioned by incisions of ligaments, and by a collection of acrid matter in a joint, or by *tophi* in the gout, would persuade us, that they are abundantly supplied with nerves.

The ligaments which connect the moveable bones commonly rise from the conjunction of the *epiphyses* of the one bone, and are inserted into the
same

(*a*) Σύνδεσμοι, νευροί, copulæ, vincula.

same place of the other; or where *epiphyses* are not, they come out from the *cervix*, and beyond the *supercilia* of the articulated bones; and after such a manner, in both cases, as to include the articulation in a purse or bag: with this difference, depending on their different motions, that where the motion is only to be in two directions, the ligaments are strongest on those sides towards which the bones are not moved; and when a great variety of motions is designed to be allowed, the ligaments are weaker than in the former sort of articulations, and are nearly of the same strength all round.

Part of the capsular ligaments is composed of the *periosteum*, continued from one bone to another, as was observed p. 32.; and their internal layer is continued on the parts of the bone or cartilage which the ligament includes (*a*).

Besides these common capsular ligaments of the joints, there are particular ones in several places, either for the firmer connection of the articulated bones, or for restraining and confining the motion to some one side; such are the *cross* and *lateral* ligaments of the knee, the *round* one of the thigh, &c.

From this account of the ligaments, we may conclude, that, *cæteris paribus*, in whatever articulation the ligaments are few, long, and weak, the motion is more free and quick; but luxations happen frequently: and, on the contrary, where the ligaments are numerous, short, and strong, the motion is more confined; but such a joint is less exposed to luxations (*b*). Whence we may judge how necessary it is to attend to the different ligaments, and the changes which have been made on them by a luxation, when it is to be reduced.

Ligaments also supply the place of bones in several cases to advantage. Thus the parts in the *pelvis* are more safely supported below by ligaments, than they could have been by bone. The ligaments placed in the great holes of the *ossa innominata*, and between the bones of the fore-arm and leg, afford convenient origin to muscles. Immoveable bones are firmly connected by them; of which the conjunction of the *os sacrum* and *innominatum* is an example. They afford a socket for moveable bones

to

(a) Nesbit, Osteogen.—Phil. Transact, n° 470. § 6.

(b) Fabric. ab Aquapend. de Articul. Part. Utilit. pars 3.

to play in, as we see part of the *astragalus* does on the ligament stretched from the heel-bone to the *scaphoid*.

Numerous inconveniencies may arise from too long or short, strong or weak, lax or rigid, ligaments.

CARTILAGES (*a*) are solid, smooth, white, elastic substances, between the hardness of bones and ligaments; and covered with a membrane, named *perichondrium*, which is of the same structure and use to them as the *periosteum* is to the bones.

Cartilages are composed of plates, which are formed of fibres disposed much in the same way as those of bones are; as might be reasonably concluded from observing bones in a cartilaginous state before they ossify, and from seeing, on the other hand, so many cartilages become bony. This may be still further confirmed by the *exfoliation* which cartilages are subject to as well as bones.

The *perichondrium* of several cartilages, for example, those of the ribs and *larynx*, has arteries which can be equally well injected with those of the *periosteum*: but the vessels of that membrane in other parts, *e. g.* the articular cartilages, are smaller; and in none of them does injection enter deep into the substance of the cartilages; nay, madder mixed with the food of animals, does not change the colour of cartilages as it does that of bones (*b*).

The granulated flesh which rises from the ends of metacarpal or metatarsal bones, when the cartilage exfoliates, after a finger or toe has been taken off at the first joint, is very sensible; from which the existence of nerves in cartilages may be inferred.

While cartilages are in a natural state, it is to be remarked, *first*, That they have no cavity in their middle for marrow: *secondly*, That their outer surface is softest, which renders them more flexible: *thirdly*, That they do not appear to change their texture near so much by acids as bones do: and, *lastly*, That as the specific gravity of cartilages is near a third less than that of bones, so the cohesion of their several plates is not so strong as in bones; whence cartilages laid bare in wounds or ulcers, are not only more liable to corrupt, but exfoliate much sooner than bones do.

Cartilages

(*a*) *Χονδρος*.

(*b*) *Philos. Transact.* n° 442. art. 8. n° 443. art. 2. n° 457. art. 4.

—*Mem. de l'Acad. des Sciences* 1739 et 1742.—*Dehtleef de Ossium callo*.

Cartilages seem to be principally kept from ossifying, either by being subjected to alternate motions of flexion and extension, the effects of which are very different from any kind of simple pressure; or by being constantly moistened (*a*). Thus the cartilages on the articulated ends of the great bones of the limbs, and the moveable ones placed between the moving bones in some articulations, which are obliged to suffer many and different flexions, and are plentifully moistened, scarce ever change into bone; while those of the ribs and *larynx* are often ossified.—The middle angular part of the cartilages of the ribs, which is constantly in an alternate state of flexion and extension by being moved in respiration, is always the last of becoming bony.—In the *larynx*, the *epiglottis*, which is oftener bended and more moistened than the other four cartilages, seldom is ossified; while the others as seldom escape it in adults.

The cartilages subservient to bones are sometimes found on the ends of bones which are joined to no other; but are never wanting on the ends and in the cavities of such bones as are designed for motion (*b*). Cartilages also are interposed between such other cartilages as cover the heads and cavities of articulated bones; nay, they are also placed between immoveable bones.

The uses of cartilages, so far as they regard bones, are, To allow, by their smoothness, such bones as are designed for motion to slide easily without detrition; while, by their flexibility, they accommodate themselves to the several figures necessary in different motions; and, by their elasticity, they recover their natural position and shape as soon as the pressure is removed.—This springy force may also assist the motion of the joint to be more expeditious; and may render shocks in running, jumping, &c. less.—To these cartilages we chiefly owe the security of the moveable articulations: for without them the bony fibres would sprout out, and intimately coalesce with the adjoining bone; whence a true *anchylosis* must necessarily follow; which never fails to happen when the cartilages are eroded by acrid matter, or ossified from want of motion or defect of liquor; as we see often happens after wounds of the joints, *paidarthrocace*, *scrophula*, and *spina ventosa*, or from old age, and long immobility.

(*a*) Havers Osteologia Nova.

(*b*) Celsus de Re Medica, lib. 8. cap. 1.

immobility of joints (*a*). Hence we may know what the annihilation is which is said to be made of the head of a bone, and of the cavity for lodging it, after an unreduced fracture (*b*).—The moveable cartilages interposed in joints serve to make the motions both freer and more safe than they would otherwise be.—Those placed on the end of bones that are not articulated, as on the *spine* of the *os ilium*, base of the *scapula*, &c. serve to prevent the bony fibres from growing out too far.—Cartilages sometimes serve as ligaments, either to fasten together bones that are immoveably joined; such are the cartilages between the *os sacrum* and *ossa ilium*, the *ossa pubis*, &c.: or to connect bones that enjoy manifest motion, as those do which are placed between the bodies of the true *vertebræ*, &c. Cartilages very often do the office of bones to greater advantage than these last could; as in the cartilages of the ribs, those which supply brims to cavities, &c.

Too great thickness or thinness, length or shortness, hardness or suppleness of cartilages, may therefore cause great disorders in the body.

The liquor which principally serves to moisten the ligaments and cartilages of the articulations is supplied by glands, which are commonly situated in the joint, after such a manner as to be gently pressed, but not destroyed by its motion. By this means, when there is the greatest necessity for this liquor, that is, when the most frequent motions are performed, the greatest quantity of it must be separated. These glands are soft and pappy, but not friable: In some of the large joints, they are of the conglomerate kind, or a great number of small glandules are wrapped up in one common membrane. Their excretory ducts are long, and hang loose, like so many fringes, within the articulation; which, by its motion and pressure, prevents obstructions in the body of the gland or its excretories, and promotes the return of this liquor, when fit to be taken up by the absorbent vessels, which must be in the joints as well as in the other cavities of the body; and, at the same time, the pressure on the excretory ducts hinders a superfluous unnecessary secretion, while
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(*a*) Columb. de Re Anat. lib. 15.—Deslandes, Hist. de l'Acad. des Sciences, 1716.—Phil. Transact. n° 215.—Ibid. n° 461. § 16.

(*b*) Hildan. de Ichor. et Melicer. acri Celsi, cap. 5.—Ruyfch, Thef. 8. n° 103.—Saltzman in Act. Petropolit. tom. iii. p. 275.

the fimbriated disposition of these excretories does not allow any of the secreted liquor to be pushed back again by these canals towards the glands (a).

Very often these fountains of slimy liquor appear only as a net-work of vessels. Frequently they are almost concealed by cellular membranes containing the fat; and sometimes small simple mucous *folliculi* may be seen (b).

The different joints have these organs in different numbers and sizes: the conglomerate ones do not vary much, especially as to situation, in the similar joints of different bodies; but the others are more uncertain.

Upon pressing any of these glands with the finger, one can squeeze out of their excretories a mucilaginous liquor, which somewhat resembles the white of an egg, or *serum* of the blood; but it is manifestly salt to the taste. It does not coagulate by acids, or by heat, as the *serum* does; but by the latter turns first thinner, and, when evaporated, leaves only a thin salt film.

The quantity of this *mucilage*, constantly supplied, must be very considerable, since we see what a plentiful troublesome discharge of glary matter follows a wound or ulcer of any joint; of which liquor the mucilage is a considerable part.

The vessels which supply liquors for making the secretion of this mucilage, and the veins which bring back the blood remaining after the secretion, are to be seen without any preparation; and after a tolerable injection of the arteries, the glands are covered with them.

In a sound state, we are not conscious of any sensibility in those glands: but in some cases which I have seen, when they inflame and suppurate, the most racking pain is felt in them; a melancholy, though a sure proof, that they have nerves.

These mucilaginous glands are commonly lodged in a cellular substance; which is also to be observed in other parts of the bag formed by the ligaments of the articulation; and contains a fatty matter, that must necessarily be attenuated, and forced through the including membranes

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into

(a) Cowper's Anatomy, explicat. of tab. 79. E. E.

(b) Morgagn. Adversar. 2. animad. 23.

into the cavity of the joint, by the pressure which it suffers from the moving bones.

If then the oil is conveyed from this cellular substance; and if the attenuated marrow passes from the *cancelli* of the bones by the large pores near their ends or in their cavities, and sweats through the cartilages there into the articulations; which it may, when assisted by the constant heat and action of the body, more easily do, than when it escapes thro' the compact substance of the bones in a skeleton: if, I say, this oil is sent to a joint, and is incorporated with the mucilage, and with the fine lymph that is constantly oozing out at the extremities of the small arteries distributed to the ligaments, one of the fittest *liniments* imaginable must be produced; for the *mucus* diluted by the lymph contributes greatly to its lubricity, and the oil preserves it from hardening. How well such a mixture serves the purpose it is designed for, *Boyle* (a) tells us he experienced in working his air-pump; for the sucker could be moved with much less force after being moistened with water and oil, than when he used either one or other of these liquors. And I believe every one, at first view, will allow the diluted mucilage to be much preferable to simple water. The *synovia* (b), as this liquor composed of oil, mucilage, and lymph, is commonly now called, while in a sound state, effectually preserves all the parts concerned in the articulations soft and flexible, and makes them slide easily on each other; by which their mutual detrition and overheating is prevented, in the manner daily practised in coach and cart wheels by besmearing them with grease and tar.

After the liquor of the articulations becomes too thin and unserviceable by being constantly pounded and rubbed between the moving bones, it is reassumed into the mass of blood by the absorbent vessels.

When the *synovia* is not rubbed betwixt the bones, it inspissates: and sometimes, when the head of a bone has been long out of its cavity, this liquor is said to fill up the place of the bone, and hinder its reduction; or, if a joint continues long unmoved, it is also said to cement the bones, and occasion a true *anchylosis* (c). If the *synovia* becomes too acrid, it erodes the cartilages and bones; as frequently happens to those who labour

(a) Physico-mechanic. Experim.

(b) *Μυζα*, mucus, axungia.

(c) Paré, Chirurgie, livre 15. chap. 18. et livre 16. chap. 5.

bour under the *lues venerea*, *scurvy*, *scrophula*, or *spina ventosa*. If this liquor is separated in too small quantity, the joint becomes stiff; and when with difficulty it is moved, a crackling noise is heard, as people advanced in years frequently experience (*a*). If the mucilage and lymph are deposited in too great quantity, and the absorbent vessels do not perform their office sufficiently, they may occasion a dropsy of the joints (*b*). From this same cause also, the ligaments are often so much relaxed, as to make the conjunction of the bones very weak: Thence arise the luxations from an internal cause; which are easily reduced, but difficultly cured (*c*). Frequently, when such a superfluous quantity of this liquor is pent up, it becomes very acrid, and occasions a great train of bad symptoms; such as swelling and pain of the joints, long sinuous ulcers and *fistulæ*, rotten bones, immobility of the joints, *marcor* and *atrophia* of the whole body, hectic fevers, &c. (*d*). From a depravity in the blood, or diseases in the organs that furnish the *synovia* of the joints, it may be greatly changed from its natural state: it may be purulent after inflammation, mucous in the white swellings, gelatinous in the rheumatism, chalky from the gout, &c. Hence a great variety of disorders in the joints (*e*).

(*a*) Galen. de Usu Part. lib. 12. cap. 2.—Fabric. ab Aquapend. de Articul. Part. Utilitat. pars 3.—Bartholin. Hist. Medic. cent. 3. hist. 11.

(*b*) Hildan. de Ichore et Meliceria acri Celsi.

(*c*) Hippocrat. de Locis in Homine, § 14. et de Articul.

(*d*) Hildan. de Ichore et Meliceria acri Celsi.

(*e*) See Reimar Dissert. de Fungo Articulari.

P A R T II.

Of the SKELETON.

THOUGH any dry substance may be called *skeleton*, yet, among anatomists, this word is universally understood to signify the bones [of animals connected together, after the teguments, muscles, bowels, glands, nerves, and vessels, are taken away (*a*).

A skeleton is said to be a *natural* one, when the bones are kept together by their own ligaments; and it is called *artificial*, when the bones are joined with wire, or any other substance which is not part of the creature to which they belonged. Small subjects, and such whose bones are not fully ossified, are commonly prepared the first way; because, were all their parts divided, the nicest artist could not rejoin them, by reason of their smallness, and of the separation of their unossified parts; whereas the bones of large adult animals are soonest and most conveniently cleaned when single, and are easily restored to and kept in their natural situation. Sometimes the skeleton of the same animal is prepared in both these ways; that is, the smaller bones are kept together by their natural ligaments, and the larger ones are connected by wires or some such substances.

Before we proceed to the division and particular description of the skeleton, it is worth while to remark, that when the bones are put into their natural situation, scarce any one of them is placed in a perpendicular bearing to another; though the fabric composed of them is so contrived, that, in an erect posture, a perpendicular line, from their common centre of gravity, falls in the middle of their common base (*b*). On this account,

(*a*) *Cadaveris crates.*

(*b*) Cowper's *Anat. of Human Bodies*, explic. of tab. 87, 88.

count, we can support ourselves as firmly, as if the axis of all the bones had been a straight line perpendicular to the horizon ; and we have much greater quickness, ease, and strength, in several of the most necessary motions we perform. It is true indeed, that wherever the bones, on which any part of our body is sustained, decline from a straight line, the force required in the muscles, to counteract the gravity of that part, is greater than otherwise it needed to have been : but then this is effectually provided for in such places, by the number and strength of the muscles. So long therefore as we remain in the same posture, a considerable number of muscles must be in a constant state of contraction ; which we know, both from reason and experience, must soon create an uneasy sensation. This we call *being weary of one posture* : An inconvenience that we should not have had in standing erect, if the bearing of all the bones to each other had been perpendicular ; but is more than compensated by the advantages above-mentioned.

The human skeleton is generally divided into the HEAD, the TRUNK, the SUPERIOR and the INFERIOR EXTREMITIES.

OF THE HEAD.

BY the HEAD is meant all that spheroidal part which is placed above the first bone of the neck. It therefore comprehends the *cranium* and bones of the *face*.

The *cranium* (a), helmet, or brain-case, consists of several pieces, which form a vaulted cavity, for lodging and defending the brain and *cerebellum*, with their membranes, vessels, and nerves.

The cavity of the *cranium* is proportioned to its contents. Hence such a variety of its size is observed in different subjects ; and hence it is neither so broad nor so deep at its fore-part, in which the anterior lobes of the brain are lodged, as it is behind, where the large posterior lobes of the brain, and the whole *cerebellum*, are contained.

The roundish figure of the skull, which makes it more capacious, and
better

(a) Κορυς, κυτος, κωδεια, σκαπιον, calva, calvaria, cerebri galea, theca et olla capitis, testa capitis, scutella capitis.

better able to defend its contents from external injuries, is chiefly owing to the equal pressure of these contained parts as they grow and increase before it is entirely ossified. It is to be observed, however, that the sides of the *cranium* are depressed below a spherical surface by the strong temporal muscles, whose action hinders here the uniform protrusion of the bones, which is more equally performed in other parts where no such large muscles are. In children, whose muscles have not acted much, and consequently have not had great effects on the bones, this depression is not so remarkable; and therefore their heads are much rounder than those of adults. These natural causes, differently disposed in different people, produce a great variety in the shapes of skulls, which is still increased by the different management of the heads of children when very young: So that one may know a *Turk's* skull by its globular figure, a *German's* by its breadth and flatness of the *occiput*, *Dutch* and *English* by their oblong shapes, &c. (a). Two advantages are reaped from this flatness of the sides of the *cranium*, viz. the enlargement of our sphere of vision, and more advantageous situation of our ears, for receiving a greater quantity of sound, and for being less exposed to injuries.

The external surface of the upper part of the *cranium* is very smooth and equal, being only covered with the *periosteum*, (common to all the bones; but in the skull, distinguished by the name of *pericranium*), the thin *frontal* and *occipital* muscles, their tendinous *aponeurosis*, and with the common teguments of the body; while the external surface of its lower part has numerous risings, depressions, and holes, which afford convenient origin and insertion to the muscles that are connected to it, and allow safe passage for the vessels and nerves that run through and near it.

The internal surface of the upper part of the skull is commonly smooth, except where the vessels of the *dura mater* have made furrows in it while the bones were soft. Surgeons should be cautious when they trepan here, lest in sawing or raising the bone where such furrows are, they wound these vessels. In the upper part of the internal surface of several skulls, there are likewise pits of different magnitudes and figures, which seem to be formed by some parts of the brain being more luxuriant and prominent

(a) Vesal. lib. 1. c. 5.

prominent than others. Where these pits are, the skull is so much thinner than any where else, that it is often rendered diaphanous, the two tables being closely compacted without a *diploe*; the want of which is supplied by vessels going from the *dura mater* into a great many small holes observable in the pits. These vessels are larger, and much more conspicuous, than any others that are sent from the *dura mater* to the skull, as evidently appears from the drops of blood they pour out when the skull is raised from the *dura mater* in a recent subject; and therefore they may furnish a sufficient quantity of liquors necessary to prevent the brittleness of this thin part. The knowledge of these pits should teach surgeons to saw cautiously and slowly through the external table of the skull when they are performing the operation of the *trepan*; since, in a patient whose *cranium* has these pits, the *dura mater* and brain may be injured before the instrument has pierced near the ordinary thickness of a table of the skull. The internal base of the skull is extremely unequal, for lodging the several parts and *appendices* of the brain and *cerebellum*, and allowing passage and defence to the vessels and nerves that go into or come out from these parts.

The bones of the *cranium* are composed of two tables, and intermediate *cancelli*, commonly called their *diploe* (a). The external table is thickest; the inner, from its thinness and consequent brittleness, has got the name of *vitrea*. Whence we may see the reason of those mischievous consequences which so often attend a collection of matter in the *diploe*, either from an external or internal cause, before any sign of such a collection appears in the teguments that cover the part of the skull where it is lodged (b).

The *diploe* has much the same texture and uses in the skull, as the *cancelli* have in other bones.

The *diploe* of several old subjects is so obliterated, that scarce any vestige of it can be seen; neither is it observable in some of the hard craggy bones at the base of the skull. Hence an useful caution to surgeons who trust to the bleeding, want of resistance, and change of sound, as certain marks, in the operation of the *trepan*, for knowing when their instrument

has

(a) Meditullium, commissura.

(b) Boneti Sepulchret. Anat. lib. 1. § 1. obs. 96.—103.

has sawed through the first table, and reached the *diploë* (a). In other people, the *diploë* becomes of a monstrous thickness, while the tables of the skull are thinner than paper.

The *cranium* consists of eight bones, six of which are said to be proper, and the other two are reckoned common to it and to the face. The six proper are the *os frontis*, two *ossa parietalia*, two *ossa temporum*, and the *os occipitis*. The common are the *os ethmoides* and *sphenoides*.

The *os frontis* forms the whole fore-part of the vault; the two *ossa parietalia* form the upper and middle part of it; the *ossa temporum* compose the lower part of the sides; the *os occipitis* makes the whole hinder part, and some of the base; the *os ethmoides* is placed in the fore-part of the base, and the *os sphenoides* is in the middle of it.

These bones are joined to each other by five *futures*; the names of which are the *coronal*, *lambdoid*, *sagittal*, and two *squamous*.

The *coronal* (b) *future* is extended over the head, from within an inch or so of the external *canthus* of one eye to the like distance from the other; which being near the place where the ancients wore their *vittæ*, *coronæ*, or garlands, this *future* has hence got its name. Though the indentations of this *future* are conspicuous in its upper part, yet an inch or more of its end on each side has none of them; for it is squamous and smooth there.

The *lambdoidal* (c) *future* begins some way below, and farther back than the *vertex* or crown of the head; whence its two legs are stretched obliquely downwards, and to each side, in form of the *Greek* letter Λ ; and are now generally said to extend themselves to the *base* of the skull: but formerly anatomists (d) reckoned the proper *lambdoid* future to terminate at the *squamous* futures; and what is extended at an angle down from that on each side, where the indentations are less conspicuous than in the upper part of the future, they called *additamentum futuræ lambdoidis* (e).

This *future* is sometimes very irregular, being made up of a great many small futures, which surround so many little bones that are generally larger and more conspicuous on the external surface of the skull than internally.

(a) Bartholin. Anat. Reform. lib. 4. cap. 4.

(c) Laudæ, proræ, hypsiloïdes.

(e) Lambdoides harmonialis, lambdoides inferior, occipitis corona.

(b) Στεφανία, arcualis, puppis.

(d) Vesal. Anat. lib. 1. cap. 6.

nally. These bones are generally called *triquetra* or *wormiana*: but some other name ought to be given them; for they are not always of a triangular figure, and older anatomists (a) than *Olaus Wormius* (b) have described them. The specific virtue which these bones were once thought to have in the cure of the epilepsy (c), is not now ascribed to them; and anatomists generally agree, that their formation is owing to a greater number of points than ordinary of ossification in the skull, or to the ordinary bones of the *cranium* not extending their ossification far enough or soon enough: in which case, the unossified interstice between such bones begins a separate ossification in one or more points; from which the ossification is extended to form as many distinct bones as there were points, that are indented into the large ordinary bones, and into each other. Probably those children who have a large opening in this place at their birth, will have the largest *ossa triquetra*. To confirm this account of the formation of these little bones, we may remark, that such bones are sometimes seen in other sutures as well as in the *lambdoid* (d); and they are sometimes in one table of the skull, and not in the other (e).

The *sagittal* suture (f) is placed longitudinally in the middle of the upper part of the skull; and commonly terminates at the middle of the *coronal* and of the *lambdoid* sutures, between which it is said to be placed as an arrow is between the string and bow. However, this suture is frequently continued through the middle of the *os frontis*, down to the root of the nose; which, some (g) say, oftener happens in women than in men: but others (h) allege, that it is to be met with more frequently in male skulls than in female. Among the skulls which I have seen thus divided,

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(a) Eustach. Ossium Examen.—Bauhin. Theat. Anat. lib. 3. cap. 5.—Paaw in Hippocrat. de Vulner. Cap. p. 56.

(b) Musæum, lib. 3. c. 26.

(c) Bauhin. et Paaw, ibid.—Bartholin. Anat. Reform. lib. 4. cap. 5.—Hildan. Epistol. 65.

(d) See examples in Vesal. lib. 1. cap. 6. fig. 4.—Paaw in Hippocrat. de Cap. Vuln.—Bartholin. Hist. Anat. cent. 1. hist. 51.—Rusch, Mus. Anat.—Sue Trad. d'Osteolog. p. 47.

(e) Hunauld, in Mem. de l'Acad. des Sciences, 1730.

(f) 'Ραβδοειδης, οβελαια, πιζιγγυσκα, Instar virgæ, nervalis, instar teli, instar veru, secundum capitis longitudinem proprensens, conjungens, columnalis, recta, acualis.

(g) Riolan. Comment. de Ossib. cap. 8. (h) Vesal. lib. 1. cap. 6. et in epitome.

the female are the most numerous. Several (*a*) have delineated and described the *sagittal* future, sometimes dividing the *occipital* bone as far down as the great hole through which the *medulla spinalis* passes. This I never saw.

In some old skulls that are in my possession, there is scarce a vestige of any of the three *futures* which I have now described. In other heads, only one or two of the futures disappear; but I never could discover any reason for thinking them disposed in such different manners in skulls of different shapes, as some ancients allege they are (*b*).

The *squamous agglutinations*, or *false futures* (*c*), are one on each side, a little above the ear, of a semicircular figure, formed by the overlapping (like one scale upon another) of the upper part of the *temporal* bones on the lower part of the *parietal*; where, in both bones, there are a great many small risings and furrows, which are indented into each other; though these inequalities do not appear till the bones are separated. In some skulls, indeed, the indentations here are as conspicuous externally as in other futures (*d*); and what is commonly called the posterior part of this squamous future, always has the evident serrated form; and therefore is reckoned by some (*e*) a distinct future, under the name of *additamentum posterius futuræ squamose*. I have seen two squamous futures on the same temple, with a semicircular piece of bone between them (*f*).

We ought here to remark, that the true squamous sort of future is not confined to the conjunction of the temporal and parietal bones, but is made use of to join all the edges of the bones on which each temporal muscle is placed (*g*): for the two parts of the sphenoidal future, which are continued from the anterior end of the common squamous future just now described, of which one runs perpendicularly downwards, and the other

(*a*) Vesal. lib. 1. cap. 5. fig. 3, 4. et in text. cap. 6.—Paaw in Cels. de Re Medic. cap. 1. —Laurent. Hist. Anat. lib. 2. cap. 16.

(*b*) Hippocrat. de Vuln. Capitis, § 1.—Galen. de Ossib. et de Ufu Part. lib. 9. cap. 17.

(*c*) Λεπιδοειδη, προσκελληματα, κροταφιαί, temporales, corticales, mendosæ, harmoniales, commifsuræ in unguem.

(*d*) Columb. de Re Anat. lib. 1. cap. 4.—Dionis, Anat. 3. Demonstr. des Os.

(*e*) Albin. de Ossib. § 54.

(*f*) Sue Trad. d'Osteolog. p. 48.

(*g*) Vesal. Anat. lib. 1. cap. 6.—Winflow, Mem. de l'Acad. des Sciences, 1720.

other horizontally forwards, and also the lower part of the coronal future already taken notice of, may all be justly said to pertain to the squamous future.—The manner how I imagine this sort of future is formed at these places is, that, by the action of the strong temporal muscles on one side, and by the pressure of the brain on the other, the bones are made so thin that they have not large enough surfaces opposed to each other to stop the extension of their fibres in length, and thus to cause the common serrated appearance of futures explained in p. 56. but the narrow edge of the one bone slides over the other. The *squamous* form is also more convenient here; because thin edges of bones, when accurately applied one to another, have scarce any rough surface to obstruct or hurt the muscle in its contraction: which is still further provided for by the manner of laying these edges on each other; for, in viewing their outside, we see the temporal bones covering the sphenoidal and parietal, and this last supporting the sphenoidal, while both mount on the frontal: From which disposition it is evident, that, while the temporal muscle is contracting, which is the only time it presses strongly in its motion on the bones, its fibres slide easily over the external edges. Another advantage still in this is, that all this bony part is made stronger by the bones thus supporting each other.

The bones of the skull are joined to those of the face by *schyndelefsis* and *futures*.—The *schyndelefsis* is in the partition of the nose.—The futures said to be common to the *cranium* and face are five, viz. the *ethmoidal*, *sphenoidal*, *transverse*, and two *zygomatic*.—Parts, however, of these futures are at the junction of only the bones of the skull.

The *ethmoidal* and *sphenoidal* futures surround the bones of these names; and in some places help to make up other futures, particularly the *squamous* and *transverse*; and in other parts there is but one future common to these two bones.

The *transverse* future is extended quite cross the face, from the external *canthus* of one orbit to the same place of the other, by sinking from the *canthus* down the outside of the orbit to its bottom; then, mounting upon its inside, it is continued by the root of the nose down the internal part of the other orbit, and rises up again on its outside to the other *canthus*. It may be here remarked, that there are some interruptions of this

future in the course I have described: for the bones are not contiguous every where; but are separated, to leave holes and apertures, to be mentioned hereafter.

The *zygomatic* futures are one on each side, being short, and slanting from above obliquely downwards and backwards, to join a process of the cheek-bone to one of the *temporal* bones, which advances towards the face; so that the two processes, thus united, form a sort of bridge or *juggum*, under which the *temporal* muscle passes; on which account the processes, and future joining them, have been called *zygomatic*.

It must be observed, that the indentations of the *futures* do not appear on the inside of the *cranium* by much so strong as on the outside; but the bones seem almost joined in a straight line: nay, in some skulls, the internal surface is found entire, while the futures are manifest without; which may possibly be owing to the less extent of the concave than of the convex surface of the *cranium*, whereby the fibres of the internal side would be stretched farther out at the edges of the bones than the exterior ones, if they were not resisted. The resistances are, the fibres of the opposite bone, the parts within the skull, and the *diplœ*; of which the last being the weakest, the most advanced fibres or *ferræ* run into it, and leave the contiguous edges equal and more ready to unite: whereas the *ferræ* of the external table have space enough for their admission between the fibres of the opposite bone; and therefore remain of the indented form, and are less liable to the concretion, whereby the futures are obliterated (*a*).—By this mechanism, there is no risk of the sharp points of the bones growing inwards, since the external *ferræ* of each of the conjoined bones rest upon the internal smooth-edged table of the other; and external forces applied to these parts are strongly resisted, because the futures cannot yield, unless the serrated edges of the one bone, and the plain internal plate of the other, are broken (*b*).

The advantages of the futures of the *cranium* are these: 1. That this *capsula* is more easily formed and extended into a spherical figure than if it had been one continued bone. 2. That the bones which are at some distance from each other at birth might then yield, and allow to the head

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(*a*) Hunauld, Memoires de l'Acad. des Sciences, 1730.

(*b*) Winslow, Memoires de l'Acad. des Sciences, 1720.

a change of shape accommodated to the passage it is engaged in: whence, in hard labour of childbed, the bones of the *cranium*, instead of being only brought into contact, are sometimes made to mount one upon the other. 3. It is alleged, that, through the futures, there is a transpiration of steams from the brain, which was the old doctrine; or some communication of the vessels without, and of those within the skull, larger here than in any other part of the *cranium*, according to some moderns; and therefore *cucuphæ*, *fomentations*, *cataplasms*, *cephalic plasters*, *blisters*, are applied, and *issues* are eroded or cut in the head, at those places where the futures are longest in forming, and where the connection of the bones is afterwards loosest, for the cure of a *phrenitis*, *mania*, *inveterate head-ach*, *epilepsy*, *apoplexy*, and other diseases of the head. The favourers of the doctrine of transpiration, or communication of vessels at the futures, endeavour to support it by observations of persons subject to head-achs, which caused death, from the futures being too closely united (*a*). 4. That the *dura mater* may be more firmly suspended by its processes, which insinuate themselves into this conjunction of the bones: for doing this equally, and where the greatest necessity of adhesion is, the futures are disposed at nearly equal distances, and the large *reservoirs* of blood, the *sinuses*, are under or near them. 5. That fractures might be prevented from reaching so far as they would in a continued bony substance. 6. That the connection at the futures being capable of yielding, the bones might be allowed to separate; which has given great relief to patients from the violent symptoms which they had before this separation happened (*b*). And it seems reasonable to believe, that the opening of the futures was of great benefit to several others who were rather judged to have been hurt by it (*c*): for we must think, that the consequences of such a force acting upon the brain as was capable of thrusting the bones asunder, must have been fatal, unless it had been thus yielded to.

Having gone through the general structure of the *cranium*, I now proceed

(*a*) Columb. de Re Anat. lib. 1. cap. 5.—Verduc. Nouvelle Osteologie, chap. 14.—Dionis, Anat. 3. demonstr. des os.

(*b*) Ephemerid. Germanic. dec. 1. ann. 4. et 5. observ. 33.

(*c*) Ephemerid. Germ. dec. 2. ann. 9. obs. 230. Ibid. cent. 10. obs. 31.—Vander Linden. Medicin. Phys. cap. 8. art. 4. § 16.—Hildan. Observ. cent. 1. obs. 1. cent. 2. obs. 7.—Baubin. Theat. Anat. lib. 3. cap. 6.—Pechlin, Observ. lib. 2. obs. 39.

ceed to examine each bone of which that brain-case consists, in the order in which I first named them.

The OS FRONTIS (a) has its name from its being the only bone of that part of the face which we call the *forehead*, though it reaches a good deal farther. It has some resemblance in shape to the shell of the *concha bivalvis*, commonly called the *cockle*: for the greatest part of it is convex externally, and concave internally, with a serrated circular edge; while the smaller part has processes and depressions, which make it of an irregular figure.

The external surface of the *os frontis* is smooth at its upper convex part; but several processes and cavities are observable below: for, at each angle of each orbit, the bone juts out, to form four processes, two internal, and as many external; which, from this situation, may well enough be named *angular*. Between the internal and external angular processes on each side, an arched ridge is extended, on which the eye-brows are placed.—Very little above the internal end of each of these *superciliary* ridges, a protuberance may be remarked, in most skulls, where there are large cavities, called *sinuses*, within the bone; of which hereafter.—Betwixt the internal angular processes, a small process rises, which forms some share of the nose, and thence is named *nasal*.—Some observe a protuberant part on the edge of the bone behind each external angular process, which they call *temporal* processes; but these are inconsiderable.—From the under part of the superciliary ridges, the frontal bone runs a great way backwards; which parts may justly enough be called *orbital* processes. These, contrary to the rest of this bone, are concave externally, for receiving the globes of the eyes, with their muscles, fat, &c.

In each of the *orbital* processes, behind the middle of the superciliary ridges, a considerable sinuosity is observed, where the *glandula innominata Galeni*, or *lachrymalis*, is lodged.—Behind each internal angular process, a small pit may be remarked, where the cartilaginous pulley of the *musculus obliquus major* of the eye is fixed.—Betwixt the two orbital processes, there is a large discontinuation of the bone, into which the cribriform part of the *os ethmoides* is incased.—The frontal bone frequently has little caverns formed in it here where it is joined to the ethmoid bone.—

Behind

(a) Μετωπν, βρεγμα, *coronale*, *inverecundum*, *puppis*, *sensus communis*, *sincipitis*.

Behind each external angular process, the surface of the frontal bone is considerably depressed where part of the *temporal* muscle is placed.

The *foramina*, or holes, observable on the external surface of the frontal bone, are three in each side.—One in each superciliary ridge, a little removed from its middle towards the nose; through which a twig of the *ophthalmic* branch of the fifth pair of nerves passes out of the orbit, with a small artery from the internal carotid, to be distributed to the teguments and muscles of the forehead.—These vessels, in some skulls, make furrows in the *os frontis*, especially in the bones of children, as has also been observed of another considerable vessel of this bone near its middle (*a*); and therefore we ought to beware of transverse incisions on either side of the *os frontis*, which might either open these vessels or hurt the nerves, while they are yet in part within the bone: for, when vessels are thus wounded, it is difficult to stop the hæmorrhagy; because the adhesion of a part of the artery to the bone hinders its contraction, and consequently styptics can have little effect; the sides of the furrow keep off compressing substances from the artery; and we would wish to shun cauteries or escharotics, because they make the bone carious; and nerves, when thus hurt, sometimes produce violent symptoms.—But, to return to the *superciliary foramina*, we must remark, that often, instead of a hole; a notch only is to be seen: nay, in some skulls, scarce a vestige even of this is left; in others, both hole and notch are observable, when the nerve and artery run separately. Frequently a hole is found on one side, and a notch on the other; at other times we see two holes; or there is a common hole without, and two distinct entries internally. The reason of this variety of a hole, notch, depression, or smoothness, in the superciliary ridge, is the different length and tension of the nerves and vessels; the shorter they are, the more they are sunk into the bone as it grows.—Near the middle of the inside of each orbit, hard by or in the *transverse suture*, there is a small hole for the passage of the nasal twig of the first branch of the fifth pair of nerves, and of a branch of the ophthalmic artery. This hole is said to be sometimes entirely formed in the *os frontis*; in most skulls, the sides of it are composed of this last bone, and of the *os planum*. It is commonly known by the name of *orbitarium inter-*
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(a) Mus. Anat. theca D. reposit. 4. n° 3.

num; though *anterius* should be added, because of the next, which is commonly omitted.—This, which may be called *orbitalum internum posterius*, is such another as the former; only smaller, and about an inch deeper in the orbit: Through it a small branch of the ocular artery passes to the nose.—Besides these six, there are a great number of small holes observable on the outer surface of this bone, particularly in the two protuberances above the eye-brows. Most of these penetrate no further than the *sinuses*, or than the *diploe* if the *sinuses* are wanting; though sometimes I have seen this bone so perforated by a vast number of these small holes, that, placed between the eye and a clear light, it appeared like a sieve.—In the orbit of the generality of *skeletons*, we may observe one, two, or more holes, which allow a passage to a hog's bristle through the skull. The place, size, and number of these, are however uncertain: They generally serve for the transmission of small arteries or nerves.

The internal surface of the *os frontis* is concave, except at the orbital processes, which are convex, to support the anterior lobes of the brain. This surface is not so smooth as the external; for the larger branches of the arteries of the *dura mater* make some furrows in its sides and back parts. The sinuosities from the luxuriant risings of the brain, mentioned when describing the general structure of the *cranium*, are often very observable on its upper part; and its lower and fore parts are marked with the contortions of the anterior lobes of the brain.—Through the middle of this internal surface, where always in children, and sometimes in old people, the bone is divided, either a ridge stands out, to which the upper edge of the *falx* is fastened; or a furrow runs, in which the upper side of the superior longitudinal *sinus* is lodged: on both these accounts, chirurgical authors justly discharge the application of the trepan here.—The reason of this difference in skulls is alleged by some authors to be this, That, in thin skulls, the ridge strengthens the bones, and in thick ones there is no occasion for it. To this way of accounting for this phenomenon, it may justly be objected, that generally very thick skulls have a large spine here, and frequently thin ones have only a furrow. Perhaps this variety may be owing to the different times of complete ossification of those parts in different subjects: for if the two sides of this bone meet before they arrive at their utmost extent of growth, they unite very firmly; and
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all their fibres endeavour to stretch themselves out where the least resistance is, that is, between the hemispheres of the brain. To support this reasoning, we may remark, that those adults whose frontal bone is divided by the sagittal future never have a ridge in this place.

Immediately at the root of this ridge or furrow, there is a small hole, which sometimes pierces through the first table, and, in other skulls, opens into the superior *sinus* of the *ethmoid* bone within the nose. In it a little process of the *falx* is lodged, and a small artery, and sometimes a vein, runs (*a*); and the superior longitudinal *sinus* begins here.—This hole, however, is often not entirely proper to the *os frontis*; for, in several skulls, the lower part of it is formed in the upper part of the base of the *crista galli*, which is a process of the *ethmoid* bone (*b*).

The *os frontis* is composed of two tables and an intermediate *diploe*, as the other bones of the *cranium* are, and in a middle degree of thickness between the *os occipitis* and the *parietal* bones; is pretty equally dense all through, except at the orbital processes, where, by the action of the eye on one side, and pressure of the lobes of the brain on the other, it is made extremely thin and diaphanous, and the *meditullium* is entirely obliterated. Since in this place there is so weak a defence for the brain, the reason appears why fencers esteem a push in the eye mortal (*c*).

The *diploe* is also exhausted in that part above the eye-brows, where the two tables of the bone separate, by the external being protruded outwards, to form two large cavities, called *sinus frontales*.—These are divided by a middle perpendicular bony partition.—Their capacities in the same subject are seldom equal; in some the right, in others the left, is largest.—And in different bones their size is as inconstant; nay, I have examined some where they were entirely wanting; which oftener happens in such as have a flat fore-head, and whose sagittal future is continued down to the nose, than in others (*d*).—In some skulls, besides the large perpendicular *septum*, there are several bony pillars, or short parti-

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tions,

(*a*) Morgagn. *Adversar.* 6. animad. 31.

(*b*) Ingrass. *Comment.* in Galen. de *Ossib.* cap. 1. comment. 8.

(*c*) Ruyfch, *Observ. Anat.-chir. observ.* 54.—Diemerbroeck, *Anat. lib.* 3. cap. 10.—Bonet. *Sepulch. Anat. lib.* 4. § 3. observ. 17.

(*d*) Fallop. *Exposit. de Ossib.* cap. 13.

tions, found in each *sinus*; in others these are wanting.—For the most part the *septum* is entire; at other times it is discontinued, and the two *sinuses* communicate. When the *sinuses* are seen in such skulls as have the frontal bone divided by the sagittal suture, the partition dividing these cavities is evidently composed of two plates, which easily separate. Each *sinus* commonly opens by a roundish small hole, at the inner and lower part of the internal angular processes, into a *sinus* formed in the nose, at the upper and back part of the *os unguis*; near to which there are also some other small *sinuses* of this bone (*a*), the greater part of which open separately nearer the *septum narium*, and often they terminate in the same common canal with the large ones.

In a natural and sound state, these cavities are of considerable advantage: for the organ of smelling being thus enlarged, the *effluvia* of odorous bodies more difficultly escape it; and their impressions being more numerous, are therefore stronger, and affect the organ more. That odorous particles may be applied to the membrane of the *sinuses*, is evident from the pain felt in this part of the forehead, when the *effluvia* of volatile spirits, or of strong aromatics, are drawn up into the nose by a quick inspiration.—These, and the other cavities which open into the nose, increase the sound of our voice, and render it more melodious, by serving as so many vaults to resound the notes. Hence people labouring under a *coryza*, or stoppage of the nose from any other cause, when they are by the vulgar, though falsely, said to speak through their nose, have such a disagreeable harsh voice.—The liquor separated in the membrane of these *sinuses*, drains down upon the membrane of the nose to keep it moist.

From the description of these *sinuses*, it is evident how useless, nay, how pernicious it must be, to apply a trepan on this part of the skull; for this instrument, instead of piercing into the cavity of the *cranium*, would reach no further than the *sinuses*; or, if the inner table was perforated, any extravasated blood that happened to be within the skull, would not be discharged outwardly, but would fall into the *sinuses*, there to stagnate, corrupt, and stimulate the sensible membranes; from which also there would be such a constant flow of glairy mucus, as would retard, if
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(a) Cowper in Drake's Anthropolog. book 3. chap. 10.

not hinder a cure, and would make the fore degenerate into an incurable *fistula*. Besides, as it would be almost impossible in this case to prevent the air passing through the nose from having constant access to the *dura mater* or brain, such a corruption would be brought on these parts as would be attended with great danger. Further, in respiration, the air rushing violently into these cavities of the *os frontis*, and passing through the external orifice whenever it was not well covered and defended, would not only prevent the closing up of the external orifice, but might otherwise bring on bad consequences (*a*).—The membrane lining these *sinuses* is so sensible, that inflammations of it must create violent torture (*b*); and worms, or other insects crawling there, must give great uneasiness (*c*).

The upper circular part of the *os frontis* is joined to the *ossa parietalia*, from one temple to the other, by the coronal suture. From the termination of the coronal suture to the external angular processes, this bone is connected to the *sphenoid* by the *sphenoidal* suture. At the external *canthi* of the eyes, its angular processes are joined by the transverse suture to the *ossa malarum*, to which it adheres one third down the outside of the orbits; whence to the bottom of these cavities, and a little up on their internal sides, these orbital processes are connected to the *sphenoidal* bone by that same suture. In some few skulls, however, a discontinuation of these two bones appears at the upper part of the long slit, near the bottom of the orbit. On the inside of each orbit, the orbital process is indented between the *cribriform* part of the *ethmoid* bone, and the *os planum* and *unguis*. The transverse suture afterwards joins the frontal bone to the superior nasal processes of the *ossa maxillaria superiora*, and to the nasal bones. And, *lastly*, its nasal process is connected to the nasal *lamella* of the *ethmoid* bone.

The *frontal* bone serves to defend and support the anterior lobes of the brain. It forms a considerable part of the cavities that contain the globes

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(*a*) Paaw de Ossibus, pars 1. cap. 7.—Palfyne Anatom. chir. traité 4. chap. 15. Nouvelle Osteologie, partie 2. chap. 3.

(*b*) Fernel. Patholog. lib. 5. cap. 7.—Saltzman Decur. observ. 10.

(*c*) Fernel Patholog. lib. 5. cap. 7.—Bartholin. Epistol. Medic. cent. 2. epist. 74.—Hist. de l'Acad. des Sciences, 1708 et 1733.

of the eyes, helps to make up the *septum narium*, organ of smelling, &c. From the description of the several parts, the other uses of this bone are evident.

In a ripe child, the frontal bone is divided through the middle; the superciliary holes are not formed; often a small round piece of each orbital process, behind the superciliary ridge, is not ossified, and there is no *sinus* to be seen within its substance.

Each of the two *OSSA PARIETALIA* (*a*), or bones serving as walls to the *encephalon*, is an irregular square; its upper and fore sides being longer than the one behind or below. The inferior side is a concave arch; the middle part receiving the upper round part of the temporal bone. The angle formed by this upper side and the fore one, is so extended, as to have the appearance of a process.

The external surface of each *os parietale* is convex. Upon it, somewhat below the middle height of the bone, there is a transverse arched ridge, of a whiter colour generally than any other part of the bone; from which, in bones that have strong prints of muscles, we see a great many converging furrows, like so many *radii* drawn from a circumference towards a centre. From this ridge of each bone the temporal muscle rises; and, by the pressure of its fibres, occasions the furrows just now mentioned. Below these, we observe, near the semicircular edges, a great many risings and depressions, which are joined to like inequalities on the inside of the temporal bone, to form the squamous suture. The temporal bone may therefore serve here as a buttress, to prevent the lower side of the parietal from starting outwards when its upper part is pressed or struck (*b*).

Near the upper sides of these bones, towards the hind part, is a small hole in each, through which a vein passes from the teguments of the head to the longitudinal *sinus*. Sometimes I have seen a branch of the temporal artery pass through this hole, to be distributed to the upper part of the *falx*, and to the *dura mater* at its sides, where it had frequent anastomoses with the branches of the arteries derived from the external carotids,

(*a*) *Καρυνης*, paria, sincipitis, verticis, arcualia, nervalia, cogitationis, rationis, bregmatis, madefactionis.

(*b*) Hunauld in Mem. de l'Acad. des Sciences, 1730.

carotids, which commonly have the name of the arteries of the *dura mater*, and with the branches of the internal carotids which serve the *falx*. In several skulls, one of the *ossa parietalia* has not this hole: in others, there are two in one bone; and in some, not one in either. Most frequently this hole is through both tables; at other times, the external table only is perforated. The knowledge of the course of these vessels may be of use to surgeons, when they make any incision near this part of the head, lest, if the vessels are rashly cut near the hole, they shrink within the substance of the bone, and so cause an obstinate hæmorrhagy, which neither ligatures nor medicines can stop.

On the inner concave surface of the parietal bones, we see a great many deep furrows, disposed somewhat like the branches of trees. The furrows are largest and deepest at the lower edge of each *os parietale*, especially near its interior angle, where sometimes a full canal is formed. They afterwards divide into small furrows in their progress upwards.—In some skulls, a large furrow begins at the hole near the upper edge, and divides into branches, which join with those which come upwards, shewing the communications of the upper and lower vessels of the *dura mater*. In these furrows we frequently see passages into the *diplœ*; and sometimes I have observed canals going off, which allowed a small probe to pass some inches into the bony substance. Some (a) tell us, that they have observed these canals piercing the bone towards the *occiput*. On the inside of the upper edge of the *ossa parietalia*, there is a large sinuosity, frequently larger in the bone of one side than of the other, where the upper part of the *falx* is fastened, and the superior longitudinal *sinus* is lodged. Generally part of the lateral *sinuses* makes a depression near the angle formed by the lower and posterior sides of these bones; and the pits made by the prominent parts of the brain are to be seen in no part of the skull more frequent, or more considerable, than in the internal surface of the parietal bones.

The *ossa parietalia* are amongst the thinnest bones of the *cranium*; but enjoy the general structure of two tables and *diplœ* the completest, and are the most equal and smooth.

These bones are joined at their fore-side to the *os frontis* by the coronal future;;

(a) Cowper's Anatomy, explic. of tab. 90. fig. 2.

future; at their long inferior angles, to the *sphenoid bone*, by part of the future of this name; at their lower edge, to the *ossa temporum*, by the squamous future, and its posterior *additamentum*; behind, to the *os occipitis*, or *ossa triquetra*, by the lambdoid future; and above, to one another, by the sagittal future.

They have no particular uses besides those mentioned in the description of their several parts, except what are included in the account of the general structure of the *cranium*.

In a child born at the full time, none of the sides of this bone are completed; and there never is a hole in the ossified part of it near to the sagittal future.

The large unossified ligamentous part of the *cranium* observable between the parietal bones and the middle of the divided *os frontis* of newborn children, called by the vulgar the *open of the head*, was imagined by the ancients to serve for the evacuation of the superfluous moisture of the brain; and therefore they named it *bregma* (*a*), or the fountain; sometimes adding the epithet *pulsatilis*, or beating, on account of the pulsation of the brain felt through this flexible ligamento-cartilaginous substance. Hence very frequently the parietal bones are called *ossa bregmatis*.

The upper middle part of the head of a child, in a natural birth, being what presents itself first at the *os uteri* (*b*), an accoucheur may reach the *bregma* with his finger, when the *os uteri* is a little opened. If the *bregma* is stretched, and the pulsation of the brain is felt through it, the child is certainly alive: but if it is shrivelled and flaccid, without any observable pulsation in it, there is some reason to suspect the child to be very weak or dead. Those who practise midwifery should therefore examine the state of the *bregma* accurately.

All the *bregma* is generally ossified before seven years of age. Several authors (*c*) say they have observed it unossified in adults; and physicians, who order the application of medicines at the meeting of the coronal and sagittal futures, seem yet to think, that a derivation of noxious humours
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(a) Palpitans vertex, foliolum, folium, triangularis lacuna.

(b) Burton's Midwifery, § 51.—Smellie's Midwifery, book 1. chap. 1. § 5.

(c) Bartholin. Anat. Reform. lib. 4. cap. 6.—Diemerbroeck, Anat. lib. 9. cap. 6.—Kerkring. Osteogen. cap. 2.

from the *encephalon*, is more easily procured at this part than any other of the skull; and that medicines have a greater effect here than elsewhere, in the internal disorders of the head. ✓

OSSA TEMPORUM (*a*), so named, say authors, from the hair's first becoming gray on the temples, and thus discovering peoples ages, are each of them equal and smooth above, with a very thin semicircular edge; which, from the manner of its connection with the neighbouring bones, is distinguished by the name of *os squamosum*. Behind this, the upper part of the temporal bone is thicker, and more unequal; and is sometimes described as a distinct part, under the name of *pars mamillaris* (*b*). Towards the base of the skull, the temporal bone appears very irregular and unequal: and this part, instead of being broad, and placed perpendicularly, as the others are, is contracted into an oblong very hard substance, extended horizontally forwards and inwards; which in its progress becomes smaller, and is commonly called *os petrosum*.

Three external processes of each temporal bone are generally described.—The first, placed at the lower and hind part of the bone, is, from its resemblance to a nipple, called *mastoides*, or *mamillaris*. It is not solid; but within is composed of *cancelli*, or small cells, which have a communication with the large cavity of the ear, the drum; and therefore sounds, being multiplied in this vaulted labyrinth, are increased before they are applied to the immediate organ of hearing. Into the mastoid process the *sternomastoideus* muscle is inserted; and to its back-part, where the surface is rough, the *trachelomastoideus*, and part of the *splenius*, are fixed.—About an inch farther forward, the second process begins to rise out from the bone; and having its origin continued obliquely downwards and forwards for some way, it becomes smaller, and is stretched forwards to join with the *os malæ*; they together forming the bony *jugum*, under which the temporal muscle passes. Hence this process has been named *zygomatic* (*c*). Its upper edge has the strong aponeurosis of the *temporal* muscle fixed into it; and its lower part gives rise to a share of

(*a*) Κορυφαῖον, κορυφαῖον, κορυφαῖον, λιπιδόειδον, πολυειδον, λιθοειδον, temporalia, lapidosa, mendosa, dura, arcualia, tympanum, armalia, faxea, parietalia.

(*b*) Albin. de Ossib. § 26.

(*c*) Καγκρος, paris, anſæ offium temporum, ossa arcualia, paria, jugalia, conjugalia.

of the *masseter*.—The fore-part of the base of this process is an oblong tubercle, which, in a recent subject, is covered with a smooth polished cartilage, continued from that which lines the cavity immediately behind this tubercle.—From the under craggy part of the *os temporum*, the third process stands out obliquely forwards. The shape of it is generally said to resemble the ancient *stylos scriptorius*; and therefore it is called the *styloid* process (a). Some authors (b) however contend, that it ought to be named *steloid*, from its being more like to a pillar. Several muscles have their origin from this process, and borrow one-half of their name from it; as *stylo-glossus*, *stylo-hyoideus*, *stylo-pharyngeus*: to it a ligament of the *os hyoides* is sometimes fixed; and another is extended from it to the inside of the angle of the lower jaw. This process is often, even in adults, not entirely ossified, but is ligamentous at its root, and sometimes is composed of two or three distinct pieces.—Round the root of it, especially at the fore-part, there is a remarkable rising of the *os petrosum*, which some have esteemed a process; and, from the appearance it makes with the *styloiform*, have named it *vaginalis*.—Others again have, under the name of *auditory* process, reckoned among the external processes that semicircular ridge which, running between the root of the *mastoid* and *zygomatic* processes, forms the under part of the external *meatus auditorius*.

The sinuosities or depressions on the external surface of each *os temporum* are these:—A long *fossa* at the inner and back part of the root of the mammary process, where the posterior head of the *digastric* muscle has its origin.—Immediately before the root of the *zygomatic* process, a considerable hollow is left for lodging the *crotaphite* muscle.—Between the *zygomatic*, *auditory*, and *vaginal* processes, a large cavity is formed; through the middle of which, from top to bottom, a fissure is observable, into which part of the ligament that secures the articulation of the lower jaw with this bone is fixed. The fore-part of the cavity being lined with the same cartilage which covers the tubercle before it, receives the *condyle* of the jaw; and in the back-part, a small share of the parotid gland and a cellular fatty substance are lodged.—At the inside of the root of the *styloid apophyse*, there is a thimble-like cavity, where the beginning of the
internal

(a) Γραφοειδης, ειλονοειδης, πληκτρον, os calaminum, sagittale, clavale, acuale, calcar capitis.

(b) Galen, de Ufu Part. lib. 2. cap. 4.—Fallop. Observ. Anatom.

internal jugular vein, or end of the lateral *sinus*, is lodged.—And as the sinuses of the two sides are frequently of unequal size, so one of these cavities is as often larger than the other (*a*).—Round the external *meatus auditorius*, several sinuosities are formed for receiving the cartilages and ligaments of the ear, and for their firm adhesion.

The *holes* that commonly appear on the outside of each of these bones, and are proper to each of them, are five.—The *first*, situated between the *zygomatic* and *mastoid* processes, is the orifice of a large funnel-like canal, which leads to the organ of hearing; therefore is called *meatus auditorius externus* (*b*).—The *second* gives passage to the *portio dura* of the seventh pair of nerves; and, from its situation between the *mastoid* and *styloid* processes, is called *foramen stylo-mastoideum* (*c*).—Some way before, and to the inside of the *styloid* process, is the *third* hole; the canal from which runs first upwards, then forwards, and receives into it the internal *carotid* artery, and the beginning of the intercostal nerve. Where this canal is about to make the turn forwards, one, or sometimes two very small holes go off towards the cavity of the ear, called *tympanum*: Through these *Valsalva* (*d*) affirms the proper artery or arteries of that cavity are sent.—On the anterior edge of this bone, near the former, a *fourth* hole is observable, being the orifice of a canal which runs outwards and backwards, in a horizontal direction, till it terminates in the *tympanum*. This, in the recent subject, is continued forward and inward, from the parts which I mentioned just now as its orifice in the skeleton, to the side of the nostrils; being partly cartilaginous, and partly ligamentous. The whole canal is named *iter a palato ad aurem*, or *Eustachian tube*.—On the external side of the bony part of this canal, and a-top of the chink in the cavity that receives the *condyle* of the lower jaw, is the course of the little nerve said commonly to be reflected from the lingual branch of the fifth pair, till it enters the *tympanum*, to run across this cavity, and to have the name of *chorda tympani*.—The *fifth* hole is very uncertain, appearing sometimes behind the *mastoid* process; sometimes it is common to the temporal and occipital bones; and in several skulls there is no such hole. The use of it,

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(*a*) Hunauld, in Mem. de l'Acad. des Sciences, 1730.

(*b*) Πόρος της ακοῆς, ὅπου τῶν ὠτῶν, fenestra aurium.

(*c*) Aquæductus Fallopii.

(*d*) De Aure Humana, cap. 2. § 22. et tab. 7. fig. 1.

when found, is for the transimission of a vein from the external teguments to the lateral *sinus*: But, in some subjects, a branch of the occipital artery passes through this hole, to serve the back-part of the *dura mater*; in others, I have seen two or three such holes; but they are oftener wanting than found. And we may, once for all, in general remark, that the largeness, number, situation, and existence, of all such holes, that for the most part allow only a passage for veins from without to the internal receptacles, are very uncertain.

The internal surface of the *offa temporum* is unequal, the upper circular edge of the squamous part having numerous small ridges and furrows for its conjunction with the parietal bones; and the rest of it is irregularly marked with the convolutions of the middle part of the brain, and with furrows made by the branches of the arteries of the *dura mater*.

From the under part of this internal surface, a larger transverse hard craggy protuberance runs horizontally inwards and forwards, with a sharp edge above, and two flat sides; one facing obliquely forwards and outwards, and the other as much backwards and inwards. To the ridge between these two sides, the large lateral process of the *dura mater* is fixed.

Sometimes a small bone, a-kin to the sesamoid, is found between the small end of this *petrous* process and the *sphenoid* bone (a).

Towards the back-part of the inside of the *os temporum*, a large deep *fossa* is conspicuous, where the *lateral sinus* lies; and frequently, on the top of the *petrous* ridge, a furrow may be observed, where a small *sinus* is situated.

The internal proper *foramina* of each of these bones are, *first*, the internal *meatus auditorius* in the posterior plain side of the *petrous* process. This hole soon divides into two; one of which is the *aqueduct* of *Fallopius*; the other ends in several very small canals (b), that allow a passage to the branches of the *portio mollis* of the seventh pair of nerves, into the *vestibule* and *cochlea*. Through it also an artery is sent, to be distributed to the organ of hearing.—The *second* hole, which is on the anterior plain side of the craggy process, gives passage to a reflected branch of the
second

(a) Riolan. Comment. de Ossibus, cap. 32.—Winslow, Exposition Anatomique de Corps Humain, traite des os secs, § 266.

(b) Valsalv. de Aure Humana, cap. 3. § 11.

second branch of the fifth pair of nerves, which joins the *portio dura* of the auditory nerve, while it is in the *aqueduct* (*a*); small branches of blood-vessels accompanying the nerves, or passing through smaller holes near this one.—The passage of the cutaneous vein into the lateral *sinus*, or of a branch of the occipital artery, is seen about the middle of the large *fossa* for that *sinus*; and the orifice of the canal of the *carotid* artery is evident at the under part of the point of the *petrous* process.

Besides these proper holes of the temporal bones which appear on their external and internal surfaces, there are two others in each side that are common to this bone, and to the *occipital* and *sphenoidal* bones; which shall be mentioned afterwards in the description of these bones.

The upper round part of the squamous bones is thin, but equal; while the low petrous part is thick and strong, but irregular and unequal, having the distinction of tables and *diploe* confounded, with several cavities, processes, and bones within its substance, which are parts of the organ of hearing. That a clear idea may be had of this beautiful, but intricate organ, anatomists generally choose to demonstrate all its parts together. I think the method good; and therefore, since it would be improper to insert a complete treatise on the ear here, shall omit the description of the parts contained within the *os petrosum* of the skeleton.

The temporal bones are joined above to the parietal bones by the squamous sutures and their posterior *additamenta*: before, to the *sphenoid* bone by the suture of that name; to the cheek-bones, by the *zygomatic* sutures; behind, to the *occipital* bone by the *lambdoid* suture and its *additamenta*; and they are articulated with the *lower jaw* in the manner which shall be described when this bone is examined.

The purposes which these two bones serve are easily collected, from the general use of the *cranium*, and from what has been said in the description of their several parts.

In an infant, a small fissure is to be observed between the thin upper part and the lower craggy part of each of these bones; which points out the recent union of these parts.—Neither *mastoid* nor *styloid* processes are yet to be seen.—Instead of a bony funnel-like external *meatus auditorius*, there is only a smooth bony ring, within which the membrane of the

M 2

drum

drum is fastened.—At the entry of the *Eustachian tube*, the side of the *tympanum* is not completed.—A little more outward than the internal auditory canal, there is a deep pit, over the upper part of whose orifice the interior semicircular canal of the ear is stretched; and, some way below this, the posterior semicircular canal also appears manifestly.

Os OCCIPITIS (*a*), so called from its situation, is convex on the outside, and concave internally. Its figure is an irregular square, or rather *rhomboid*; of which the angle above is generally a little rounded; the two lateral angles are more finished, but obtuse; and the lower one is stretched forward in form of a wedge, and thence is called by some the *cuneiform process*.—If one would, however, be very nice in observing the several turns which the edges of the *os occipitis* make, five or seven sides, and as many angles, of this bone might be described.

The external surface is convex, except at the cuneiform apophyse, where it is flattened. At the base of this triangular process, on each side of the great hole, but more advanced forwards than the middle of it, the large oblong protuberances, named the *condyles*, appear, to serve for the articulation of this bone with the first *vertebra* of the neck. The smooth surface of each of these *condyloid* processes is longest from behind forwards; where, by their oblique situation, they come much nearer to each other than they are at their back-part. Their inner sides are lower than the external, by which they are prevented from sliding to either side out of the cavities of the first *vertebra* (*b*). In some subjects, each of these plain smooth surfaces seems to be divided by a small rising in its middle; and the lower edge of each condyle, next the great *foramen*, is discontinued about the middle, by an intervening notch: whence some (*c*) allege, that each of these *apophyses* is made up of two protuberances.—Round their root a small depression and spongy roughness is observable, where the ligaments for surrounding and securing their articulations adhere. Though the motion of the head is performed on the condyles, yet the centre of gravity of that globe does not fall between them, but is a good way further forward; from which mechanism it is evident, that the muscles which pull the head back must be

(*a*) *ἰσχυρ.* basilare, proræ, memoriæ, pixidis, fibrosum, nervosum, lambde.

(*b*) Galen. de Ufu Part. lib. 12. cap. 7.

(*c*) Diembroeck, Anat. lib. 9. cap. 6.

be in a constant state of contraction; which is stronger than the natural contraction of the proper flexors, else the head would always fall forwards, as it does when a man is asleep, or labours under a palsy, as well as in infants, where the weight of the head far exceeds the proportional strength of these muscles. This seeming disadvantageous situation of the condyles is however of good use to us, by allowing sufficient space for the cavities of the mouth and *fauces*, and for lodging a sufficient number of muscles, which commonly serve for other uses; but may at pleasure be directed to act on the head, and then have an advantageous lever to act with, so as to be able to sustain a considerable weight appended, or other force applied, to pull the head back.

Somewhat more externally than the *condyles*, there is a small rising and semilunated hollow in each side, which make part of the holes common to the *occipital* and *petrous* bones. Immediately behind this, on each side, a scabrous ridge is extended from the middle of the condyle towards the root of the *mastoid* process. Into this ridge the *musculus lateralis*, commonly ascribed to *Fallopian*, is inserted. About the middle of the external convex surface, a large arch runs cross the bone; from the upper lateral parts of which the *occipital* muscles have their rise: to its middle the *trapezii* are attached; and half way between this and the great hole, a lesser arch is extended.—In the hollows between the middle of these arches, the *complexi* are inserted; and in the depressions more external and further forward than these, the *splenii* are inserted. Between the middle of the lesser arch and the great hole, the little hollow marks of the *recti minores* appear; and on each side of these the fleshy insertions of the *obliqui superiores* and *recti majores* make depressions. Through the middle of the two arches a small sharp *spine* is placed, which serves as some sort of partition between the muscles of different sides, or rather is owing to the action of the muscles depressing the bone on each side of it, while this part is free from their compression. These prints of the muscles on this bone are very strong and plain in some subjects, but are not so distinct in others. All round the great *foramen* the edges are unequal, for the firmer adhesion of the strong circular ligament which goes thence to the first *vertebra*. One end of each *lateral* or *moderator* ligament of the head, is fixed to a rough surface at the fore-part of each condyle; and the

the *perpendicular* one is connected to a rough part of the edge of the great hole between the two condyles. —Immediately before the condyles, two little depressions are made in the external surface of the cuneiform process, for the insertion of the *recti anteriores minores* muscles, which are unjustly ascribed to *Cowper*: And still further forward, near the *sphenoid* bone, are two other such depressions, for the reception of the *recti anteriores majores*. When we consider the size of the prints of muscles on the occipital bone, before and behind its condyles, and at the same time compare their distances from these centres of motion of the head, we must see how much stronger the muscles are which pull the head backwards, than those are which bend it forward; and how much greater force the former acquire by the long lever they act with, than the latter which are inserted so near the condyles. This great force in the extensor muscles is altogether necessary, that they might not only keep the head from falling forward in an erect posture, but that they might support it when we bow forward in the most necessary offices of social life, when the weight of the head comes to act at right angles on the *vertebræ* of the neck, and obtains a long lever to act with.

On the inner surface of the *os occipitis* we see two ridges; one standing perpendicular, the other running horizontally across the first. The upper part of the perpendicular limb of the cross, to which the *falx* is fixed, is hollowed in the middle, or often on one side, for the reception of the *superior longitudinal sinus*; and the lower part of it has the small or third process of the *dura mater* fastened to it, and is sometimes hollowed by the *occipital sinus*. Each side of the horizontal limb is made hollow by the lateral sinuses inclosed in the transverse process of the *dura mater*; the *fossa* in the right side being generally a continuation of the one made by the longitudinal sinus in the perpendicular limb, and therefore is larger than the left one (*a*). Round the middle of the cross there are four large depressions separated by its limbs; the two upper ones being formed by the back-part of the brain, and the two lower ones by the *cerebellum*.—Farther forward than the last-mentioned depressions, is the lower part of the *fossa* for the lateral *sinus* on each side. The inner surface of the cuneiform apophyse is made concave for the reception of the *medulla oblongata*,

(a) Morgagn. *Advers. Anat.* 6. animad. 1.

gata, and of the *basilar* artery. A furrow is made on each side near the edges of this process, by a *sinus* of the *dura mater*, which empties itself into the lateral *sinus* (a).

The holes of this bone are commonly five proper, and two common to it and to the *temporal* bones. The first of the proper holes, called *foramen magnum* (b), from its size, is immediately behind the wedge-like process, and allows a passage to the *medulla oblongata*, *nervi accessorii*, to the vertebral arteries, and sometimes to the vertebral veins. At each side of this great hole, near its fore-part, and immediately above the condyles, we always find a hole, sometimes two, which soon unite again into one that opens externally; through these the ninth pair of nerves go out of the skull. The fourth and fifth holes pierce from behind the *condyle* of each side into the *fossæ* of the lateral *sinuses*; they serve for the passage of the cervical veins to these *sinuses*. Often one of these holes is wanting, sometimes both, when the veins pass through the great *foramen*. Besides these five, we frequently meet with other holes near the edges of this bone, for the transmission of veins; but their number and diameter are very uncertain. The two common *foramina* are the large irregular holes, one in each side, between the sides of the *cuneiform* process and the edges of the *petrous* bones. In a recent subject, a strong membrane runs cross from one side to the other of each of these holes; in some heads, I have seen this membrane ossified, or a bony partition dividing each hole; and in the great number of adult skulls, there is a small sharp-pointed process stands out from the *os petrosum*, and a more obtuse rising in the occipital bone, between which the partition is stretched. Behind this partition, where the largest space is left, the *lateral sinus* has its passage; and before it the eighth pair of nerves and *accessorius* make their exit out of the skull; and some authors say an artery passes through this hole, to be bestowed on the *dura mater*.

The *occipital* bone is among the thickest of the *cranium*, though unequally so; for it is stronger above, where it has no other defence than the common teguments, than it is below, where, being pressed by the lobes of the brain and *cerebellum* on one side, and by the action of the muscles on the other, it is so very thin, as to be diaphanous in many skulls: but then

(a) Albin. de Orib. § 65.

(b) Rachitidis, medullæ spinalis.

then these muscles ward off injuries ; and the ridges and spines, which are frequent here, make it sufficiently strong to resist ordinary forces.

The tables and *diplœ* are tolerably distinct in this bone, except where it is so thin as to become diaphanous.

The occipital bone is joined above to the *ossa parietalia*, and *triquetra* when present, by the *lambdoid* future ; laterally to the temporal bones, by the *additamenta* of the *lambdoid* future ; below to the *sphenoid* bone, by the end of its cuneiform process, in the same way that epiphyses and their bones are joined : for in children a ligamentous cartilage is interposed between the occipital and sphenoid bones, which gradually turns thinner as each of the bones advances, till their fibres at last run into each other ; and, about sixteen or eighteen years of age, the union of these two bones becomes so intimate, that a separation cannot be made without violence. The *os occipitis* is joined by a double articulation to the first *vertebra* of the neck, each condyle being received into a superior oblique process of that *vertebra*. What motion is allowed here, we shall consider afterwards, where the *vertebræ* are described.

The uses of this bone appear from the preceding description, and therefore need not be repeated.

An infant born at the full time has this bone divided, by unossified cartilages, into four parts.—The first of these is larger than the other three, is of a triangular shape, and constitutes all the part of the bone above the great *foramen*. Generally fissures appear in the upper part and sides of this triangular bone, when all the cartilage is separated by maceration ; and sometimes little distinct bones are seen towards the edges of it. The second and third pieces of this bone are exactly alike, and situated on each side of the great *foramen* : from which very near the whole condyles are produced ; and they are extended forwards almost to the fore-part of the hole for the ninth pair of nerves. The fourth piece is the cuneiform process, which forms a small share of the great hole, and of these for the ninth pair of nerves, and of the condyles ; betwixt it and the *sphenoid* bone a cartilage is interposed.

Of the eight bones which belong to the *cranium*, there are only two which are not yet described, viz. the *ethmoid* and *sphenoid*. These we already mentioned, in compliance to the generality of writers on this subject,

subject, as bones common to the *cranium* and *face*, because they enter into the composition of both: but the same reason might equally be used for calling the frontal bone a common one too. I shall, however, pass any idle dispute about the propriety of ranging them, and proceed to examine the structure of the bones themselves.

OS ETHMOIDES (*a*), or the sieve-like bone, has got its name from the great number of small holes with which that part of it first taken notice of is pierced. When this bone is entire, the figure of it is not easily described: but by a detail of its several parts, some idea may be afforded of the whole; and therefore I shall distinguish it into the *cribriform lamella* with its process, the *nasal lamella*, *cellulæ*, and *ossa spongiosa*.

The thin horizontal *lamella* is all (except its back-part) pierced obliquely by a great number of small holes, through which the filaments of the olfactory nerves pass. In a recent subject, these holes are so closely lined by the *dura mater*, that they are much less conspicuous than in the *skeleton*. From the middle of the internal side of this plate a thick process rises upwards; and being highest at the fore-part, gradually becomes lower as it is extended backwards. From some resemblance which this process was imagined to have to a cock's comb, it has been called *crista galli* (*b*). The *falx* is connected to its ridge, and to the unperforated part of the cribriform plate. When the *crista* is broke, its base is sometimes found to be hollow, with its cavity opening into the nose (*c*). Immediately before the highest part of this process is the blind hole of the *frontal* bone; which, as was formerly remarked, is often in a good measure formed by a notch in the fore-part of the root of the *crista*.

From the middle of the outer surface of the *cribriform lamella*, a thin solid plate is extended downwards, having the same common base with the *crista galli*. Generally it is not exactly perpendicular, but is inclined to one side or other, and therefore divides the cavity of the nose unequally. Its inclination to one side, and flexure in the middle, is sometimes so great, that it fills up a large share of one of the nostrils, and has been mistook for a *polypus* there. It is thin at its rise, and rather still

N

thinner

(*a*) Cribriforme, σπογγοειδής, spongiforme, cristatum.

(*b*) Verruca prædura, septum ossis spongiosi.

(*c*) Palfyn. Anat. Chir. traité 4. chap. 15.

thinner in its middle ; yet afterwards, towards its lower edge, it becomes thicker, that its conjunction with the bones and middle cartilage of the nose might be firmer.

At a little distance from each side of this external process, a cellular and spongy bony substance depends from the cribriform plate. The number and figure of the cells in this irregular process of each side, are very uncertain, and not to be represented in words ; only the cells open into each other, and into the cavity of the nose : the uppermost, which are below the aperture of the frontal *sinuses*, are formed like funnels. The outer surface of these cells is smooth and plain, where this bone assists in composing the orbit ; at which place, on each side, it has got the name of *os planum* ; on the upper edge of which a small notch or two may sometimes be observed, which go to the formation of the internal orbital holes ; as was remarked in the description of the frontal bone.

Below the cells of each side, a thin plate is extended inwards ; and then bending down, it becomes thick and of a spongy texture.—This spongy part is triangular, with a straight upper edge placed horizontally, an anterior one slanting from above downwards and forwards, and with a pendulous convex one below.—The upper and lower edges terminate in a sharp point behind.—The side of this pendulous spongy part next to the *septum narium* is convex, and its external side is concave.—These two processes of the *ethmoid* bone have got the name of *ossa spongiosa*, or *turbinata superiora*, from their substance, figure, and situation.

All the prominences, cavities, and *meanders* of this *ethmoid* bone, are covered with a continuation of the membrane of the nostrils in a recent subject.—Its horizontal cribriform plate is lodged between the orbital processes of the *frontal* bone, to which it is joined by the *ethmoid* suture, except at the back part where it is connected with the *cuneiform* bone, by a suture common to both these bones, though it is generally esteemed part of the *sphenoidal*.—Where the *ossa plana* are contiguous to the frontal bone within the orbit, their conjunction is reckoned part of the transverse suture.—Farther forward than the *ossa plana*, the cells are covered by the *ossa unguis* ; which are not only contiguous to these cells, but cannot be separated from them without breaking the bony substance ; and therefore, in justice, those bones ought to be demonstrated as part of the

ethmoid

ethmoid bone.—Below the *ossa unguis* and *plana*, these cells and *ossa spongiosa* are overlapped by the *maxillary* bones.—The cellular part of each *palate* bone is contiguous to each *os planum* and cells backwards.—The lower edge of the nasal perpendicular plate is received into the furrow of the *vomer*.—Its posterior edge is joined to the fore-part of the *processus azygos* of the *sphenoid* bone.—Its upper edge joins the *nasal* process of the *frontal* and *nasal* bones, and its anterior one is connected to the middle cartilage of the nose.

From all which, the uses of this bone are evident, viz. to sustain the anterior lobes of the brain; to give passage to the olfactory nerves, and attachment to the *falx*; to enlarge the organ of smelling, by allowing the membrane of the nose a great extent; to straiten the passage of the air through the nose, by leaving only a narrow winding canal, on the sensible membranous sides of which the substances conveyed along with the air must strike; to form part of the orbit of the eyes and *septum narium*; while all its parts are so light, as not to be in hazard of separating by their weight; and they are so thin, as to form a large surface without occupying much space. This brittle substance, however, is sufficiently protected from external injuries by the firm bones which cover it.

If this bone is seized on by any corroding matter, we may easily conceive what destruction may ensue. Hence it is, that an *ozæna* is difficult to cure; and that in violent *scurvies*, or in the *lues venerea*, the fabric of the nose, the eyes, and life itself, are in danger.—The situation of the nasal plate may shew us how dangerous a fracture of the bones of the nose may be, when made by a force applied to their middle fore-part, of a person in whom this nasal plate is perpendicular.

The *ethmoid* bone of ripe children is divided into two by a perpendicular cartilage, which, when ossified, is the *crista galli* and nasal plate; but its other parts are ossified and complete.

OS SPHENOIDES (*a*), or wedge-like bone, so called because of its situation in the middle of the bones of the *cranium* and face, is of such an irregular figure, that I know not any thing to which it may be likened,

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unless,

(*a*) Cuneiforme, *πολυμορφον* multiforme, *paxillum*, *cribratum*, *palati*, *colatorii*, *cavilla*, *basilare*.

unless, perhaps, it bear some faint resemblance to a bat with its wings extended.

When we view the external surface of the *os sphenoides*, two or three remarkable processes from each side of it may be observed, which are all of them again subdivided.—The first pair is the two large lateral processes or wings; the upper part of each of which is called the *temporal process*, because they join with the temporal bones in forming the temples, and the seat for some share of the *crotaphite* muscles. That part of the wings which juts out towards the inside, somewhat lower than the temporal *apophyses*, and is smooth and hollowed where it makes up part of the orbit, is thence named *orbital processes*. Behind the edge, separating these two processes, there is often a small groove made by a branch of the superior maxillary nerve in its passage to the temporal muscle. The lowest and back part of each wing, which runs out sharp to meet the *offa petrosa*, has been styled the *spinous process*: from near the point of which a sharp pointed process is frequently produced downwards, which some call *styloid form*, that affords origin to the *ptery-staphylinus externus* muscle. From this styloid process a very small groove is extended along the edge of the bone to the hollow at the root of the internal plate of the following processes, which forms part of the *Eustachian tube* (a).—The second pair of external processes of the *cuneiform* bone is the two which stand out almost perpendicular to the base of the skull. Each of them has two plates, and a middle *fossa* facing backwards; and should, to carry on our comparison, be likened to the bat's legs, but are commonly said to resemble the wings of that creature; and therefore are named *pterygoid* or *aliform* (b) processes. The external plates are broadest, and the internal are longest. From each side of the external plates the *pterygoid* muscles take their rise. At the root of each internal plate a small hollow may be remarked, where the *musculus ptery-staphylinus internus*, or *circumflexus palati*, rises, and some share of the cartilaginous end of the *Eustachian tube* rests; and, at the lower end of the same plate, is a hook-like rising or process, round which the tendon of the last-named muscle plays, as on a pulley. From the edge of the external plates some small sharp spikes stand out; but their
number

(a) Winslow, Exposition Anatomique du Corps Humain, traité des os secs, § 233.

(b) Naviculares.

number and bulk are uncertain.—To these another pair may be added, to wit, the little triangular thin process, which comes from each side of the body of the *sphenoid* bone, where the *pterygoid* processes are rising from it, and are extended over the lower part of the aperture of the *sinus* as far as to join the *ethmoid* bone, while their body hangs down into the *nares* (a).—Besides these pairs of processes, there is a sharp ridge which stands out from the middle of its base: because it wants a fellow, it may be called *processus azygos*. The lower part of this process, where it is received into the *vomer*, is thick, and often not quite perpendicular, but inclining more to one side than the other. The fore-part of this process, where it joins the nasal plate of the *os ethmoides*, is thin and straight. These two parts have been described as two distinct processes by some.

The depressions, sinuosities, and *fossæ*, on the external surface of this *sphenoid* bone, may be reckoned up to a great number, viz. two on the temporal *apophyses* where the *crotaphite* muscles lodge.—Two on the *orbital* processes, to make way for the globes of the eyes.—Two between the *temporal* and *spinous* processes, for receiving the temporal bones.—Two between the plates of the *pterygoid* processes, where the *musculi pterygoidei interni* and *ptery-staphylini interni* are placed.—Two between the *pterygoid* and *orbital* processes, for forming the holes common to this and to the *cheek* and *maxillary* bones. Two on the lower ends of the *aliform* processes, which the *palate* bones enter into.—Two at the roots of the *temporal* and *pterygoid* processes, where the largest share of the external *pterygoid* muscles have their rise.—Two at the sides of the *processus azygos*, for forming part of the nose, &c.

What I described under the name of *temporal* and *spinous processes* on the outside of the skull, are likewise seen on its inside, where they are concave, for receiving part of the brain; and commonly three *apophyses* on the internal surface of the *sphenoid* bone are only mentioned.—Two, rising broad from the fore-part of its body, become smaller as they are extended obliquely backwards.—The third, standing on a long transverse base near the back-part of the body of this bone, rises nearly erect, and of an equal breadth, terminating often in a little knob on each side. The three are called *clinoid*, from some resemblance which they were thought

to

(a) Albin. Tab. Off. 5. fig. 2. 6. A. A.—Bertin. Mem. de l'Acad. des Sciences 1744.—Sue, planche vii. fig. 2, 3, 4, 5, 6.

to have to the supporters of a bed. Sometimes one or both the anterior *clinoid* processes are joined to the sides of the posterior one, or the body of the bone itself.—From the roots of the anterior *clinoid* processes the bone is extended on each side outwards and forwards, till it ends in a sharp point, which may have the name of the *transverse spinous* processes.—Between, but a little farther back than the two anterior *clinoid* processes, we see a protuberance considerably smaller than the posterior *clinoid* process, but of its shape.—Another process from between the transverse processes often forces itself forwards into the *os ethmoides*.

Within the skull, there are two sinuosities on the internal part of each wing of the *sphenoid* bone, for receiving the middle part of the brain.—One between the transverse spinous processes, for lodging the part of the brain where the *crura medullæ oblongatæ* are.—Immediately before the third or middle *clinoid* process, a single pit may generally be remarked, from which a *fossa* goes out on each side to the holes through which the optic nerves pass. The pit is formed by the conjoined optic nerves; and in the *fossæ* these nerves are lodged, as they run divided within the skull.—Between that third protuberance and the posterior *clinoid* process, the larger pit for the *glandula pituitaria* may be remarked. This cavity, because of its resemblance to a *Turkish* saddle, is always described under the name of *fella Turcica*, or *ephippium*.—On the sides of the posterior *clinoid* process a *fossa* may be remarked, that stretches upwards, then is continued forwards along the sides of the *fella Turcica*, near to the anterior *clinoid* processes, where a pit on each side is made. These *fossæ* point out the course of the two internal *carotid* arteries, after they have entered the skull.—Besides all these, several other *fossæ* may be observed, leading to the several holes, and imprinted by the nerves and blood-vessels.

The holes on each side of the *os sphenoides* are six proper, and three common.—The *first* is the round one immediately below the anterior *clinoid* processes, for the passage of the optic nerve, and of the branch of the internal *carotid* artery that is sent to the eye.—The *second* is the *foramen lacerum*, or large slit between the transverse spinous and orbital processes: the interior end of which slit is large; and, as it is extended outwards, it becomes narrower. The outer end of it is formed in the *os frontis*; and therefore this might be reckoned among the common *foramina*.

ramina. Through it the third, fourth, the first branch of the fifth, and the greater share of the sixth pair of nerves, and an artery from the internal carotid, go into the orbit. Sometimes a small branch of the external carotid enters near its end, to be distributed to the *dura mater* (a), and a vein, some call it the *venous duct*, or *Nuck's aqueduct*, returns through it to the cavernous *sinus*.—The *third* hole, situated a little below the one just now described, is called *rotundum*, from its shape. It allows passage to the second branch of the fifth pair of nerves, or superior maxillary nerve, into the bottom of the orbit.—The *fourth* is the *foramen ovale*, about half an inch behind the round hole. Through it the third branch of the fifth pair, or inferior maxillary nerve, goes out; and sometimes a vein from the *dura mater* passes out here (b).—Very near the point of the spinous process is the *fifth* hole of this bone: it is small and round, for a passage to the largest artery of the *dura mater*, which often is accompanied with a vein.—The *sixth* proper hole (c) cannot be well seen till the cuneiform bone is separated from all the other bones of the *cranium*; for one end of it is hid by a small protuberance of the internal plate of the *pterygoid* process, and by the point of the *processus petrosus* of the *temporal* bone. Its canal is extended above the inner plate of the *pterygoid* process; and where it opens into the cavity of the nose, it is concealed by the thin laminous part of the *palate* bone. Through it a considerable branch of the second branch of the *fifth* pair of nerves is reflected.—Often, in the middle of the *fella Turcica*, a small hole or two pierce as far as the cellular substance of the bone; and sometimes, at the sides of this *fella*, one or more small holes penetrate into the *sphenoidal sinuses*. These observations afforded some anatomists (d) an argument of weight in their days, in defence of *Galen* (e), who asserted the descent of the *pituita* that way into the *sinuses* below.

The *first* of the common holes is that unequal fissure at the side of the *fella*

(a) Winslow, Exposition Anatomique du Corps Humain, traite des arteres, § 60. et de la tete, § 26.

(b) Ingrassi. Commentar. in Galen. de Ossib. lib. 1. comment. 8.

(c) Vesal. Anat. lib. 1. cap. 12.—Eustach. Tab. 46. fig. 13. & 16.—Vidus Vidius, Anat. lib. 2. cap. 2. explicat. tab. 5. & tab. 5. fig. 8, 9, 10. lit. O.

(d) Jac. Sylv. Calumniæ secundæ amolitio.—Laurent. Hist. Anat. lib. 2. quest. 11.

(e) Galen. de Usu Part. lib. 9. cap. 1.

fella Turcica, between the extreme point of the *os petrosum* and the *spinous* process of the cuneiform bone. This hole only appears after the bones are boiled: for, in a recent subject, its back-part is covered by a thin bony plate that lies over the internal carotid artery; and further forward it is filled with a cartilaginous ligament, under which the cartilaginous part of the *Eustachian tube* is placed: It was by this passage that the ancients believed the *slimy matter* was conveyed from the emunctory of the brain, the *glandula pituitaria*, to the *fauces*.—The *second* common hole is the large discontinuation of the external side of the orbit, left between the orbital processes of the cuneiform bone, the *os maxillare, malæ*, and *palati*. In this large hole the fat for lubricating the globe of the eye and temporal muscle is lodged; and branches of the superior maxillary nerve, with small arteries from the carotid and veins, pass.—The *third* hole is formed between the base of this bone and the root of the orbital process of the palate-bone of each side. Through this a branch of the external carotid artery, and of the second branch of the fifth pair of nerves, are allowed a passage to the nostrils, and a returning vein accompanies them. Sometimes, however, this hole is proper to the palate-bone, being entirely formed out of its substance.

Under the *fella Turcica*, and some way farther forward, but within the substance of the *sphenoid* bone, are two *sinuses*, separated by a bony plate. Each of them is lined with a membrane, and opens into the upper and back part of each nostril by a round hole, which is at their upper fore-part. This hole is not formed only by the *os sphenoides*, which has an aperture near as large as any transverse section of the *sinus*, but also by the *palate* bones which are applied to the fore-part of these *sinuses*, and close them up, that hole only excepted which was already mentioned. Frequently the two *sinuses* are of unequal dimensions; and sometimes there is only one large cavity, with an opening into one nostril. These cavities are likewise said (*a*) to be extended sometimes as far back as the great *foramen* of the occipital bone. In other subjects they are not to be found, when the bone is composed of large cells (*b*). Some (*c*) mention a cavity within the partition of the *sinuses*; but it is small.—The *sphenoidal sinuses* serve the same uses as the frontal do.

As

(a) Albin. de Ossib. § 39.

(b) Vesal. lib. 1. cap. 6.

(c) Id. ibid.

As this bone is extremely ragged and unequal, so its substance is of very different thickness, being in some places diaphanous; in others it is of a middle thickness, and its middle back-part surpasses the greatest share of the *cranium* in thickness.

The *os sphenoides* is joined, by its wings, to the *parietal* bones above, to the *os frontis* and *ossa malarum* before, to the *temporal* bones behind;—by the fore-part of its body and spinous processes, to the *frontal* and *ethmoid* bones;—by its back-part, behind the two *sinuses*, to the *occipital*, where it looks like a bone with the *epiphyses* taken off, and, as was formerly observed in the description of the occipital bone, it cannot be separated without violence in adults;—to the *palate* bones, by the ends of the *pterygoid* processes, and still more by the fore-part of the internal plates of the *pterygoid* processes and of the *sinuses*;—to the *maxillary* bones, by the fore-part of the external *pterygoid* plates;—to the *vomer* and nasal plate of the *os ethmoides*, by the *processus azygos*. All these conjunctions, except the last, which is a *schindelysis*, are said to be by the future proper to this bone; though it is at first sight evident, that several other futures, as the *transverse*, *ethmoidal*, &c. are confounded with it.

We see now how this bone is joined to all the bones of the *cranium*, and to most of the upper jaw; and therefore obtained the name of the *wedge-like bone*.

The uses are so blended with the description, as to leave nothing new to be added concerning them.

The *sphenoidal bone* is almost complete in a *fetus* of nine months; only the great *alæ* separate after maceration from the body of the bone.—The *processus azygos* is very large and hollow;—the thin triangular processes are not ossified;—the internal surface of the body is unequal and porous;—the *sinuses* do not appear.

Whoever is acquainted with each bone of the *cranium*, can without difficulty examine them as they stand united, so as to know the shapes, sizes, distances, &c. of their several parts, and the forms, capacities, &c. of the cavities formed by them; which is of great use towards understanding the anatomy of the parts contiguous to, contained within, or connected to them. Such a review is necessary, after considering each class of bones. Thus the orbits, nostrils, mouth, face, head, spine, *thorax*,

pelvis, trunk, extremities, and skeleton, ought likewise to be examined.

The *FACE* is the irregular pile of bones, composing the fore and under part of the head, which is divided by authors into the upper and lower *maxillæ*, or jaws.

The *superior maxilla* (*a*) is the common designation given to the upper immoveable share of the face; though, if we would follow *Celsus* (*b*), we should apply the word *maxilla* to the lower jaw only, and the name *mala* to this upper jaw. In complaisance to prevailing custom, I shall, however, use the terms as now commonly employed. The shape of the superior jaw cannot easily be expressed; nor is it necessary, provided the shape and situation of all the bones which compose it are described. It is bounded above by the transverse suture; behind, by the fore-part of the *sphenoid* bone; and below by the mouth.

The upper jaw consists of six bones on each side; of a thirteenth bone, which has no fellow, placed in the middle; and of sixteen teeth. The thirteen bones are, two *ossa nasi*, two *ossa unguis*, two *ossa malarum*, two *ossa maxillaria*, two *ossa palati*, two *ossa spongiosa inferiora*, and the *vomer*.

The *ossa nasi* are placed at the upper part of the nose;—the *ossa unguis* are at the internal *cantbi* of the orbits;—*ossa malarum* form the prominence of the cheeks;—*ossa maxillaria* form the side of the nose, with the whole lower and fore-part of the upper jaw, and the greatest share of the roof of the mouth;—*ossa palati* are situated at the back-part of the palate, nostrils, and orbit;—*ossa spongiosa* are seen in the lower part of the *nares*;—and the *vomer* helps to separate these two cavities.

The bones of the *upper jaw* are joined to the bones of the skull by the *schindylesis* and sutures already described as common to the *cranium* and *face*; and they are connected to each other by *gomphosis* and fifteen sutures.

The *gomphosis* only is where the teeth are fixed in their sockets; and the *schindylesis* is only where the edges of the *vomer* are joined to other bones.

The sutures are generally distinguished by numbers, which have been differently

(*a*) Σάγων, γένος, mandibula.

(*b*) Lib. 8. cap. 1.

differently applied; and therefore I join those (a) who prefer the giving names to each; which may be easily contrived from their situation, or from the bones which they connect.

The first is the *anterior nasal* (b); which is straight, and placed longitudinally in the middle fore-part of the nose.

The second and third are the *lateral nasal* (c); which are at each side of the nose, and almost parallel to the first future.

Each of the two *lacrymal* is almost semicircular, and is placed round the *lacrymal* groove.

The sixth and seventh are the *internal orbital*; each of which is extended obliquely from the middle of the lower side of an orbit to the edge of its base.

The two *external orbitals* are continued, each from the end of the internal orbital to the under and fore part of the cheek.

The tenth is the *mylarchial*; which reaches only from the lower part of the *septum narium* to between the two middle *dentes incisores*.

The *longitudinal palate* (d) future stretches from the middle of the foremost teeth through the middle of all the palate.

The *transverse palate* one (e) runs across the palate, nearer the back than the fore part of it.

Each of the two *palato-maxillary* is at the back-part of the side of each nostril.

The fifteenth is the *spinous*; which is in the middle of the lower part of the nostrils. This may perhaps be rather thought a double *schindylesis*.

The connection of the *ossa spongiosa* to the side of each nostril is so much, by a membrane in young subjects, by a sort of hook, and afterwards by concretion or union of substance in adults, that I did not know well how to rank it: But if any chooses to call it a future, the addition of two *transverse nasal* futures may be made to those above named.

These futures of the face (commonly called *harmoniae*) have not such

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conspicuous

(a) Vander Linden. Medicin. Physiolog. cap. 13. art. 2. § 10.—Rolfinc. Anat. lib. 2. cap. 25.—Shenk. Schol. Part. § ult. par. 2. cap. 5.

(b) Nasalis recta.

(c) Nasalis obliqua.

(d) Laquearia, palataria recta.

(e) Arcuata, palatina postica.

conspicuous indentations as those of the skull have; the bones here not having substance enough for forming large indentations, and there being less necessity for security against external injuries, or any internal protruding force, than in the *cranium*.—These futures often disappear in old people, by the bones running into each other; which can do little prejudice, because the principal use of the bones being so numerous here, is to allow them to be extended into a proper form.

It is evident, from the manner of conjunction of these bones, that they can have no motion, except in common with the *cranium*.

The purposes which this pile of bones serves will be shown in the description which I am to give of each of them.

OSSA NASI, so named from their situation at the root of the nose, are each of an irregular oblong square figure, being broadest at their lower end, narrowest a little higher than their middle, and becoming somewhat larger at the top, where they are ragged and thickest, and have a curvature forwards, that their connection with the *frontal* bone might be stronger.—These bones are convex externally, and thereby better resist any violence from without; and they are concave internally, for enlarging the cavity of the nose.

The lower edge of these bones is unequal; and is stretched outwards and backwards, to join the cartilages of the nostrils.—Their anterior side is thick, especially above, and unequal, that their conjunction to each other might be stronger; and a small rising may be remarked on their inner edge, where they are sustained by the *septum narium*.—Their posterior side, at its upper half, has externally a depression, where it is overlapped some way by the *maxillary* bones, while its lower half covers these bones: By which contrivance, they do not yield easily to pressure applied to their fore-part or sides.

A small hole is frequently to be observed on their external surface, into which two, three, or four holes, which appear internally, terminate, for the transmission of small veins; sometimes the holes go no further than the *cancelli* of the bones.

The *nasal bones* are firm and solid, with very few *cells* or *cancelli* in them; the thin substance of which they consist not requiring much marrow.

They

They are joined above to the *frontal* bone by the middle of the *transverse* future;—behind, to the *maxillary* bones, by the *lateral nasal* futures;—below, to the cartilages of the nose;—before, to one another, by the *anterior nasal* future;—internally, to the *septum narium*.

These bones serve to cover and defend the root of the nose.

In an infant, the *nasal bones* are proportionally shorter, and less thick at their upper part, than in an adult, but are otherwise complete.

OSSA UNGUIS, or LACRYMALIA, are so named, because their figure and magnitude are something near to those of a nail of one's finger, and because the tears pass upon them into the nose.

Their external surface is composed of two smooth concavities and a middle ridge.—The depression behind forms a small share of the orbit for the eye-ball to move on; and the one before is a deep perpendicular canal or *fossa*, larger above than below, containing part of the lacrymal sac and duct. This is the part that ought to be pierced in the great operation for the *fistula lacrymalis*.—This *fossa* of the bone is cribriform, or has a great number of small holes through it, that the filaments from the membrane which lines it, insinuating themselves into these holes, might prevent a separation of the membrane, and secure the bone in its natural situation.—The ridge between these two cavities of the *os unguis* is the proper boundary of the orbit at its internal *canthus*, and beyond which surgeons should not proceed backwards in performing operations here.—The internal or posterior surface of this bone consists of a furrow in the middle of two convexities.

The substance of the *os unguis* is as thin as paper, and very brittle; which is the reason that those bones are often wanting in skeletons, and need little force to pierce them in living subjects.

Each of these bones is joined above to the *frontal* bone by part of the *transverse* future;—behind, to the *os planum* of the *ethmoid* bone by the same future;—before, and below, to the *maxillary* bone, by the *lacrymal* future.—Internally, the *ossa unguis* cover some of the *sinus ethmoidales*; nay, are really continuous with the bony *lamellæ* which make up the sides of these cells; so that they are as much part of the *ethmoid* bone as the *ossa plana*.

These unguiform bones compose the anterior internal parts of the orbits, lodge a share of the lacrymal sac and duct, and cover the *ethmoid* cells..

cells.—Their situation and tender substance make a rash operator in danger of destroying a considerable share of the organ of smelling, when he is performing the operation of the *fistula lacrymalis*: but when these bones are hurt, they cast off without much difficulty, and consequently the wound is soon cured, unless the patient labours under a general *cacothecis*, or there is a predisposition in the bones to *caries*; in which case, a large train of bad symptoms follow, or, at best, the cure proves tedious.

These bones are fully formed in a new-born child.

OSSA MALARUM (*a*) was the name given by *Celsus*, as was already remarked, to all the upper jaw; but is now appropriated to the prominent square bones which form the cheek on each side.—Before, their surface is convex and smooth; backward, it is unequal and concave, for lodging part of the *crotaphyte* muscles.

The four angles of each of these bones have been reckoned processes by some.—The one at the external *canthus* of the orbit, called the *superior orbital* process, is the longest and thickest.—The second terminates near the middle of the lower edge of the orbit in a sharp point, and is named the *inferior orbital* process.—The third, placed near the lower part of the cheek, and thence called *maxillary*, is the shortest, and nearest to a right angle.—The fourth, which is called *zygomatic*, because it is extended backwards to the *zygoma* of the temporal bone, ends in a point, and has one side straight and the other sloping.—Between the two orbital angles there is a concave arch, which makes about a third of the external circumference of the orbit, from which a fifth process is extended backwards within the orbit, to form near one third of that cavity; and hence it may be called the *internal orbital* process.—From the lower edge of each of the *ossa malarum*, which is between the maxillary and zygomatic processes, the *masseter* muscle takes its origin; and from the exterior part of the *zygomatic* process, the *musculus distortor oris* rises; in both which places the surface of the bone is rough.

On the external surface of each cheek-bone, one or more small holes are commonly found, for the transmission of small nerves or blood-vessels from and sometimes into the orbit.—On the internal surface are the holes for the passage of the nutritious vessels of these bones.—A notch on
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(*a*) Jugalia vel zygomatica, hypopia, subocularia.

the outside of the internal *orbital* process of each of these bones assists to form the great slit common to this bone, and to the sphenoid, maxillary, and palate bones.

The substance of these bones is, in proportion to their bulk, thick, hard, and solid, with some *cancelli*.

Each of the *ossa malarum* is joined, by its superior and internal orbital processes, to the *os frontis*, and to the orbital process of the *sphenoid* bone, by the *transverse* future.—By the edge between the internal and inferior orbital processes, to the *maxillary* bone, by the *internal orbital* future.—By the side between the maxillary and inferior orbital process, again to the maxillary bone, by the *external orbital* future.—By the zygomatic process, to the *os temporum*, by the *zygomatic* future.

The cheek-bones are entire, and fully ossified in all their parts, in infants.

OSSA MAXILLARIA SUPERIORA, are the largest bones, and constitute the far greater part of the upper jaw; which has appropriated the name of *maxillaria* to them. The figure of one of them, or of the two when joined, is so irregular, that words can scarce give an idea of it.

The processes of each *os maxillare* may be reckoned seven.—The *first* is the long nasal one at its upper and fore part; which is broad below, and turns smaller as it rises upwards, to make the side of the nose.—At the root of this, a transverse ridge may be observed within the nostrils, which supports the fore-part of the upper edge of the *os spongiosum inferius*.—The *second* is produced backwards and outwards from the root of the nasal process, to form the lower side of the orbit; and therefore may be called *orbital*.—The edge of this orbital process, and the ridge of the nasal one which is continued from it, make a considerable portion of the external circumference of the orbit.—From the proper orbital process, a very rough triangular surface is extended downwards and outwards, to be connected to the cheek-bone; and therefore may be called the *malar* process; from the lowest protuberant part of which some share of the masseter muscle takes its rise.—Behind the orbital process, a large tuberosity or bulge of the bone appears, which is esteemed the *fourth* process. On the internal part of this we often meet with a ridge, almost of the same height with that in the nasal process, which runs transversely, and

is covered by a similar ridge of the *palate* bone, on which the back-part of the upper edge of the *os spongiosum inferius* rests.—The convex back-part of this tuberosity is rough, for the origin of part of the external *pterygoid* muscle (*a*); and more internally is scabrous, where the palate and sphenoid bones are joined to it.—That spongy protuberance (*b*) at the lower circumference of this bone, where the sockets for the teeth are formed, is reckoned the *fifth*.—The *sixth* is the horizontal plate, which forms the greater part of the base of the nostrils and roof of the mouth: its upper surface, which belongs to the nostrils, is very smooth; but the other below is arched and rough, for the stronger adhesion of the membrane of the mouth, which is stretched upon it, and in chewing, speaking, &c. might otherwise be liable to be separated.—The *seventh* rises like a spine from the inner edge of the last, and forms a small part of the partition of the nostrils.

The depressions in each *maxillary* bone are, 1. A sinuosity behind the orbital process, made by the *temporal* muscle. 2. A pit immediately before the same process, where the origin of the *musculus elevator labiorum communis*, and *elevator labii superioris*, with a branch of the fifth pair of nerves, are lodged securely. 3. The hollow arch of the palate. 4. The semicircular great notch, or entry to the lower part of the nostrils, betwixt the root of the nasal process and spine of the palate-plate. Below this, the fore-part of the bone is flattened, or sometimes hollowed, by the *musculus depressor labii superioris*. 5. Sockets for the teeth (*c*): The number of these sockets is uncertain: for the same number of teeth is not in all people, and the four backmost teeth of each side of each jaw vary greatly in their number of roots; and when the teeth of a living person fall out, or are taken away, the sockets fill up with an osseous net-work, which becomes solid afterwards. 6. The *lacrymal fossa* in the *nasal process*, which assists the *os unguis* to form a passage for the *lacrymal duct*. This part of the bone forming this *fossa* is so firm and strong, that a surgeon scarce can perforate it with the ordinary instruments for the *fistula lacrymalis*; and therefore ought to avoid it in doing this operation.—Immediately on

(a) Albin. de Ossib. § 79.

(b) ρατυία.

(c) Βοδρία, αλμισχοι, alveoli, fossulæ, mortariola, fræna, locelli, cavæ, pralsepiola, locula-
menta.

on the outside of this there is a small depression, from which the inferior or lesser oblique muscle of the eye has its origin (*b*). 7. The canal on the upper part of the great tuberosity within the orbit, which is almost a complete hole: in this a branch of the superior maxillary nerve passes.—Besides these, the superior surface of the great bulge is concave, to receive the under part of the eye.—Immediately above the transverse ridge in the nasal process, a small hollow is formed by the *os spongiosum*.—In some subjects, the nasal process has a small round pit above the lacrymal duct, where the little tendon or ligament of the orbicular muscle of the eye-lids is inserted. It is this tendon, and not the tendon of the larger oblique muscle of the eye, which there is some hazard of cutting in the operation of the *fistula lacrymalis*.

The holes of this bone are two proper and two common, which are always to be found, besides several others, whose magnitude, number, &c. are uncertain.—The first of the proper is the *external orbitar*, immediately below the orbit; by which the infra-orbitar branch of the second branch of the fifth pair of nerves, and a small artery, come out, after having passed in the canal at the bottom of the orbit described *numb.* 7. of the depressions.—This hole is often double, and that when the nerve has happened to split before it has escaped from the bone.—The second is the *foramen incisivum*, just behind the fore-teeth, which, at its under part, is one irregular hole common to both the *maxillary* bones when they are joined: but, as it descends, soon divides into two, three, or sometimes more holes; some of which open into each nostril. Through them small arteries and veins, and a twig of the second branch of the fifth pair of nerves pass, and make a communication between, or join the lining coats of the nose and mouth.—In some subjects, *Steno's* duct may be traced some way on the side of these passages next to the nose, and small orifices may be observed opening into the mouth.

The first common hole is that which appears at the inner side of the back-part of the *tuberosity* and of the sockets of the teeth, and is formed by a *fossa* in this bone, and a corresponding one in the *os palati*: Through it a nerve, which is a branch of the second branch of the fifth pair, runs to the palate.—The other common hole is the great slit in the outside

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of

(*b*) Winslow, Exposition Anatomique des Os Sees, § 276.

of the orbit described already as the second common hole of the sphenoid bone.

On the nasal process often holes may be observed for the passage of vessels to the substance of the bones; and at the back-part of each tuberosity several *foramina* are placed, for the transmission of nerves to the cavity within: But these are uncertain.

All the body of the *maxillary* bone is hollow, and leaves a large *sinus* a-kin to the *frontal* and *sphenoid*; which is commonly, but unjustly, called *antrum Highmorianum* (*a*). When the *os maxillare* is single, or separated from all the other bones of a skeleton, its *antrum* appears to have a large aperture into the nostrils: but, in a recent subject, it is so covered at its back-part by the *palate* bone, in the middle by the *os spongiosum inferius*, before by a strong membrane, that one or sometimes two holes, scarce larger than a crow-quill, are only left at the upper part; which, after a short winding progress, open into the nostrils between the two *ossa spongiosa*.—At the bottom of this cavity, we may often observe some protuberances, in which the small points of the roots of the teeth are contained (*b*).—This cavern and the sockets of the teeth are often divided by the interposition only of a very thin bony plate, which is liable to be eroded by acrid matter collected in the *antrum*, or to be broke in drawing a tooth (*c*). The symptoms of a collection of matter here naturally led us to the practice of pulling out the teeth, and piercing through this plate into the *antrum*, to procure an evacuation of the collected matter; by which considerable service is frequently done (*d*).

The *maxillary sinuses* have the same uses as the *frontal* and *sphenoidal*; and the situation of the *sinuses* is such, that the liquor drilling from them, from the cells of the ethmoid and palate bones, and from the lacrymal ducts, may always moisten all the parts of the membrane of the *nares* in the different situations which the head is in.

Though the membranes which line the *frontal*, *sphenoidal*, and *maxillary sinuses*, are continuations of the one which covers the bones within the nose; yet they are much thinner than it is, and have so much smaller vessels,

(*a*) Genæ. (*b*) Highmore, Disquis. Anat. lib. 3. part 2. cap. 1. (*c*) Id. ibid.

(*d*) Cowper in Drake's Anthropol. book 3. chap. 10.—Medical Essays and Observations, vol. v. art. 30. or no 27. of this Collection.

vessels, that the injection, which makes the membrane of the nose red all over, fills only some few vessels of the *maxillary sinuses*, and scarce is observed in the *frontal* and *sphenoidal*. Are not the larger vessels intended for a more plentiful secretion of a viscid liquor to defend the membrane from the effects of the *perflatus*, which is constantly through the nose? Are not the membranes which have the smallest vessels, *cæteris paribus*, the most sensible? Are not many phenomena of smelling, inflammations of these parts, *megrims*, *polypi*, &c. depending on this structure of these membranes?

The substance of the *ossa maxillaria* is compact and firm, except at the inferior processes, in which the teeth are lodged, where it is very spongy.

The *maxillary* bones are joined above by the upper ends of their nasal processes to the *os frontis*, by the *transverse* future;—at the sides of these processes, to the *ossa unguis*, by the *lacrymal* futures;—to the *nasal* bones, by the *lateral nasal* futures;—by their orbital processes, to the *cheek* bones, by the *external orbital* futures;—by the internal sides of the internal orbital processes, to the *ossa plana*, by part of the *ethmoidal* future;—by the back-part of the tuberosities, to the *palate* bones, by the *futuræ palato-maxillares*;—by the posterior edges of their palatine *lamellæ*, to the *ossa palati*, by the *transverse* palate future;—by their nasal *spines*, to the *vomer*, by the *spinous* future;—by their sockets, to the teeth, by *gomphosis*;—by the internal edge of the palate-plate, to one another, by the *longitudinal* palate future, on the upper and fore-part of which a furrow is left for receiving the cartilage which forms the partition of the nostrils;—between the fore-part of the nostrils and mouth, to each other, by the *mylashial* future;—sometimes they are connected to the *ossa spongiosa inferiora*, by a plain concretion or union of substance.

These bones form the greater part of the nose and of the roof of the mouth, and a considerable share of the orbit. They contain sixteen teeth, give rise to muscles, transmission to nerves, &c. as mentioned in the description of their several parts.

In each of the *maxillary* bones of a new-born child, the external orbital process is hollow, with remarkable holes in it:—there are five sockets for the teeth; of which the two posterior are very large, and, when di-

vided by a second cross partition, make the number of sockets six (*a*).—The palate-plate is cribriform about the middle. The great tuberosity is not formed;—instead of the *antrum*, there is only an oblong depression at the side of the nostrils.

OSSA PALATI are commonly described as two small square bones, at the back-part of the palate or roof of the mouth; though they are of much greater extent, being continued up the back-part of the nostrils to the orbit (*b*). Each palate-bone may therefore be divided into four parts; the palate square bone, the pterygoid process, nasal *lamella*, and orbital process.

The square bone is unequally concave, for enlarging both the mouth and cavity of the nose. The upper part of its internal edge rises in a spine, after the same manner as the palate-plate of the *maxillary* bone does, to be joined with the *vomer*.—Its anterior edge is unequally ragged, for its firmer connection with the palate-process of the *os maxillare*.—The internal edge is thicker than the rest, and of an equal surface, for its conjunction with its fellow of the other side.—Behind, this bone is somewhat in form of a crescent, and thick, for the firm connection of the *velum pendulum palati*; the internal point being produced backwards, to afford origin to the *palato-staphylinus* or *azygos* muscle.—This square bone is well distinguished from the *pterygoid* process by a perpendicular *fossa*, which, applied to such another in the *maxillary* bone, forms a passage for the palatine branch of the fifth pair of nerves; and by another small hole behind this, through which a twig of the same nerve passes.

The *pterygoid* process is somewhat triangular, having a broad base, and ending smaller above. The back-part of this process has three *fossæ* formed in it: the two lateral receive the ends of the two plates of the sphenoid bone, that are commonly compared to a bat's wing; the middle *fossa* makes up a part of what is commonly called the *fossa pterygoidea*. The fore-side of this palatine pterygoid process is an irregular concave, where it receives the back-part of the great *tuberosity* of the *maxillary* bone.—Frequently several small holes may be observed in this triangular process, particularly

(*a*) Albin. Osteogen. tab. 5. fig. 45.—Ungebu. de Dentit. secund. jun. § 1.

(*b*) Eustach. tab. 47. fig. 1, 3, 6, 7, 8.—Vidus Vidius, de Anat. lib. 2. cap. 2. explicat. tab. 6. fig. 19.—Winflow, Memoires de l'Acad. des Sciences, 1720.

particularly one near the middle of its base, which a little above communicates with the common and proper holes of this bone already taken notice of.

The *nasal lamella* of this bone is extremely thin and brittle, and rises upwards from the upper side of the external edge of the square-bone, and from the narrow extremity of the *pterygoid* process; where it is so weak, and at the same time so firmly fixed to the *maxillary* bone, as to be very liable to be broken in separating the bones.—From the part where the plate rises, it runs up broad on the inside of the *tuberosity* of the *maxillary* bone, to form a considerable share of the sides of the *maxillary sinus*, and to close up the space between the *sphenoid* and the great bulge of the *maxillary* bone, where there would otherwise be a large slit opening into the nostrils (*a*). From the middle internal side of this thin plate, a cross ridge placed on such another of the *maxillary* bone is extended; on it the back-part of the *os spongiosum inferius* rests.—Along the outside of this plate, the perpendicular *fossa* made by the palate nerve is observable.

At the upper part of this nasal plate, the palate-bone divides into two processes, which I already named *orbital*;—between which and the body of the *sphenoid* bone, that hole is formed which I mentioned as the last of the holes common to the *sphenoid* bone.—Sometimes this hole is wholly formed in the *os palati*, by a cross plate going from the one *orbital* process to the other. A nerve, artery, and vein, belonging to the nostrils, pass here.—The anterior of the two *orbital* processes is the largest, and has its fore-part contiguous to the back-part of the *maxillary sinus*, and its upper surface appears in the bottom of the orbit, behind the back-part of the *os maxillare* and *planum*.—It has cells behind, resembling those of the *ethmoid* bone, to which it is contiguous: it is placed on the aperture of the *sinus sphenoidalis*, so as to leave only a round hole at its upper fore-part.—The other part of the *orbital* process is extended along the internal side of the upper back part of the *maxillary tuberosity*, to the base of the *sphenoid* bone, between the root of the *processus azygos* and the *pterygoid* process.

The palate square part of this palate-bone, and its *pterygoid* process, are

are firm and strong, with some *cancelli*; but the nasal plate and orbital processes are very thin and brittle.

The palate-bones are joined to the *maxillary*, by the fore-edge of the palate square bone, by the *transverse palate* future:—By their thin nasal plates, and part of their orbital processes, to the same bones, by the *palato-maxillares* futures:—By their *pterygoid* processes, and back-part of the nasal plates, to the *ala vespertilionum*, by the *sphenoid* future:—By the transverse ridges of the nasal plates, to the *ossa spongiosa inferiora*, by contact; hence frequently there is an intimate union of the substance of these bones in old skulls:—By the orbital processes, to the *ossa plana* and *cellulæ ethmoideæ*, by the *ethmoid* future:—To the body of the *sphenoid* bone, by the *sphenoid* future:—By the internal edge of the square bones, to each other, by the *longitudinal* palate-future; and by their nasal spines, to the *vomer*, by the *spinous* future.

The palate-bones form part of the palate, nostrils, orbits, and *fossæ pterygoideæ*; and they cover part of the *sinus maxillares*, *sphenoidales*, and *ethmoidei*.

These bones are very complete in a new-born infant, the nasal plates being then thicker and stronger than in adults; but the orbital processes have not the cells which appear in the bones of adults.

When we are acquainted with the history of these bones, the reason is evident why the eyes are so much affected in ulcers of the palate, as to be often attended with blindness, which frequently happens in an ill-managed *lues venerea*; or why, on the other hand, the palate suffers from an *ægylops* (a).

OSSA TURBINATA, or *spongiosa inferiora*, resemble the superior *ossa spongiosa* in shape and substance, but have their anterior and upper edges contiguous to the transverse ridges of the nasal processes of the *maxillary* and *palate bones*.—From their upper straight edge, two small processes stand out: the posterior, which is the broadest, descends to cover some of the *antrum Highmorianum*; the anterior rises up to join the *os unguis*, and to make part of the *lacrymal duct*.

Below the spongy bones already mentioned, there are sometimes two others, one in each nostril, which seem to be a production of the sides of the

(a) Hoffman. in Ephemerid. German. cent. 1. & 2. observ. 135.

the maxillary *sinus* turned downwards (*a*). When this third sort of spongy bones is found, the middle one of the three in each nostril is the largest, and the lowest is the smallest.—Besides all these, there are often several other small bones standing out into the nostrils, that, from their shape, might also deserve the name of *turbinata*, but are uncertain in their bulk, situation, and number (*b*).

The names of these bones sufficiently declare their spongy substance, which has no firm external plate covering it.

They are joined to the *ossa maxillaria*, *palati*, and *unguis*, in old subjects, by a firm union of substance: and as this happens also frequently in people of no great age, some (*c*) are of opinion that they should be esteemed part of the palate-bones; others (*d*) think, that, since their upper edge is continued by a plate to part of the *os ethmoides*, they ought to be esteemed to be a part of this bone.

Their use is, to straiten the nostrils, to afford a large surface for extending the organ of smelling, to cover part of the *antra maxillaria*, and to assist in forming the under-part of the lacrymal ducts, the orifices of which into the nose are concealed by these bones.

The *ossa turbinata* are nearly complete in a new-born infant.

VOMER, or bone resembling a plough-share, is the thirteenth of the upper jaw, without a fellow, forming the lower and back parts of the partition of the nose (*e*).

The figure of this bone is an irregular rhomboid.—Its sides are flat and smooth.—Its posterior edge appears in an oblique direction at the back-part of the nostrils.—The upper one is firmly united to the base of the *sphenoid* bone, and to the nasal plate of the *ethmoid*; and, when it can be got separated, is hollow, for receiving the *processus azygos* of the *sphenoid*.—The anterior edge has a long furrow in it, where the middle cartilage of the nose enters.—The lower edge is firmly united to the nasal spines of the maxillary and palate bones.—These edges of this bone are much thicker than its middle, which is as thin as the finest paper; by which,

(*a*) Cowper in Drake's Anthropol. book 3, chap. 10.

(*b*) Santorin. Observat. Anatomic. cap. 5. § 9.

(*c*) Id. ibid. cap. 5. § 7.

(*d*) Hunauld, in Memoires de l'Acad. des Sciences, 1730.

(*e*) Columb. de Re Anat. lib. 1. cap. 8.—Fallop. Observat. Anatom.

which, and the firm union or connection this bone has above and below, it can very seldom be separated entire in adults: but in a child it is much more easily separated entire, and its structure is more distinctly seen; wherefore I shall examine all its parts of such a subject.

Its situation is not always perpendicular, but often inclined and bended to one side, as well as the nasal plate of the *ethmoid* bone.

The *vomer* is convex at its upper part; and then is straight as it is extended downwards and forwards, where it is composed of two plates; the edges of which have a great number of small processes, disposed somewhat like the teeth of a saw, but more irregularly, and several of them are reflected back. Between these plates a deep *fossa* is left, which, so far as the top of the curvature, is wide, and has strong sides, for receiving the *processus azygos* of the *sphenoid* bone. Beyond the arch forwards, the *fossa* is narrower and shallower gradually to the point of the bone, receiving for some way the nasal *lamella ethmoidea*; which, after the ossification is complete, is so closely united to the *vomer* by the little processes piercing into its substance, as to prevent any separation; on which account it has been esteemed by some (a) a part of the *ethmoid* bone. The middle cartilage of the nose fills up what remains of the *fossa* at its fore-part.—The posterior edge of the *vomer*, which appears above the back-part of the palate-bones, is broader above; but, as it descends forwards, becomes thinner, though it is still solid and firm.—The lower edge of this bone, which rests on the nasal spine of the *palate* and *maxillary* bones, has a little furrow on each side of a small middle ridge, answering to the spines of the bones of different sides, and the interstices between them. This edge and the upper one meet in the pointed fore-end of this bone.

The body of the *vomer* has a smooth surface, and solid but thin substance; and towards its sides, where it is thickest, some *cancelli* may be observed when the bone is broken.

It is joined above to the *sphenoid* and *ethmoid* bones, and to the middle cartilage of the nose, by *sphenoides*;—below, to the maxillary and palate-bones, by the *spinous* future.

The *vomer* divides the nostrils; enlarges the organ of smelling, by allowing

(a) Lieutaud, *Essais Anatomiques* 1. sect. l'os ethmoide.

lowing place for expanding the membrane of the nose on its sides; and sustains the palate-plates of the *maxillary* and *palate* bones, which otherwise might be in hazard of being pressed into the nostrils; while the *vomer* is secured from shuffling to one side or other by the double *schindylesis*, by which it is joined to the bones above and below.

These, then, are all the bones which compose the upper jaw, except the teeth, which are so much a-kin to those of the lower jaw, that I choose to make one description serve for both; in which the differences observable in them shall be remarked, after the second part of the face, the lower jaw, is examined; because the structure of the teeth cannot be well understood, until the case in which they are set is explained.

MAXILLA INFERIOR (*a*), the lower jaw, consists only of one moveable bone, and sixteen teeth incased into it.

This bone, which is somewhat of the figure of the Greek letter γ , is situated at the lower part of the face, so as its convex middle part is forwards, and its legs are stretched back. It is commonly divided into the chin, sides, and processes.—The *chin* is the middle fore-part; the extent of which to each side is marked on the external surface by the holes observable there, and internally by the beginning of an oblique ridge.—Beyond these, the *sides* appear; and are continued till the bone, by bending upwards, begins to form the processes.

On the fore-part of the *chin*, a transverse ridge appears in the middle, on each side of which the *musculi quadrati*, or *depressores labii inferioris*, and the *levator labii inferioris*, depress the bone: and, below these prints, a small rising may be observed, where the *depressores* commence.—On the back-part of the chin, sometimes three, always two, small protuberances appear in the middle. To the uppermost, when it is seen, the *frænum* of the tongue is connected. From the middle one, the *musculi genioglossi* rise; and from the lowest the *geniobyoidei* have their origin. Below the last, we see two rough sinuosities, formed by the *digastric* muscles.

At the lower and fore part of the external surface of each side of the lower jaw, a small eminence may be observed, where the *depressor labiorum communis* rises. Near the upper edge of the side, a ridge runs

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lengthwise, to which the under-part of the *musculus buccinator* is connected.—Internally, towards the upper edge of each side, another ridge appears, from which the *mylohyoidei* have their origin, and to which the internal membrane of the gums adheres.

In the upper edge of both chin and sides, are a great many deep pits or sockets, for receiving the roots of the teeth. The number and magnitude of these sockets are various, because of the different number, as well of the teeth themselves as of their roots, in different people. These sockets in this lower jaw, as well as in the upper one, are less deep as old age comes on: when freed from the teeth by any means, they are some time after filled up with an osseous net-work, which at last becomes entirely solid, and as smooth as any other part of the bone; so that, in a great many old jaws, one cannot observe a vestige of the sockets: but then the jaw-bone becomes less, and much narrower (*a*).—Hence we may know why the chin and nose of edentulous people are much nearer than before the teeth were lost; while their lips either fall in towards the mouth, or stand prominent forwards.—When new teeth are protruded, new sockets are formed (*b*).—The lower edge of the chin and sides is smooth and equal, and is commonly called the *base* of the lower jaw.—The ends of the base, where the jaw turns upwards, are called its *angles*: the external surface of each of which has several inequalities upon it, where the *masseter* muscle is inserted; as the internal surface also has, where the *pterygoideus internus* is inserted, and a ligament, extended from the *styloid* process of the temporal bone, is fixed.

The processes are two on each side.—The anterior sharp thin *coronoid* ones have the *crotaphite* muscles inserted into them.—The posterior processes, or *condyles* (*c*), terminate in an oblong smooth head, supported by a *cervix*. The heads, whose greatest length is transverse, and whose convexity is turned forwards, are tipped with a cartilage, as the articulated parts of all other moved bones are.—The fore-part of the root and neck of these *condyloid* processes are a little hollow and rough, where the external *pterygoid* muscles are inserted.

The holes of the lower jaw are two on each side; one at the root of the processes internally, where a large branch of the third branch of the
fifth

(*a*) Vesal. Anat. lib. 1. cap. 10.

(*b*) Fallop. Observ. Anat.

(*c*) Articularorii.

fifth pair of nerves enters with an artery, and a vein returns. A small sharp process frequently juts out backwards from the edge at the fore-part of this hole, to which a ligament, extended from the temporal bone, is fixed (*a*), which saves the nerve and vessels from being too much pressed by the *pterygoid* muscles.—From the lower side of this hole, either a small superficial canal or a furrow descends, where a branch of the nerve is lodged, in its way to the *mylo-hyoideus* muscle and sublingual gland (*b*).—The other hole is external, at the confines of the chin, where branches of the nerve and vessels come out.—The canal betwixt these two holes is formed in the middle of the substance of the bone; and is pierced by a great number of small holes, by which the nerves and blood-vessels of the *cancelli* and teeth pass. This canal is continued a little further than the external hole at the chin.—On account of the vessels and nerves in the lower jaw, fractures of it may be attended with dangerous symptoms.

The surface of the lower jaw is hard and firm, except at the spongy sockets, where, however, it is stronger than the upper jaw.—Its internal substance is cellular, without any solid partition between the *cancelli* in its middle.—At the base, especially of the chin, where this bone is most exposed to injuries, the solid sides of it are thick, compact, and hard.

The lower jaw generally receives the roots of sixteen teeth into its sockets by *gomphosis*; and its *condyloid* processes, covered with cartilage, are articulated with the *temporal* bones, in a manner that is not commonly described right: For, as was already mentioned in the description of the temporal bones, not only the fore-part of the cavity between the *zygomatic*, *auditory*, and *vaginal* processes, but also the adjoining tubercle at the root of the *zygomatic* process of each *os temporum*, is covered with a smooth cartilage, for this articulation.—Here also an intermediate moveable cartilage is placed, which being thin in the middle, and thick at the edges, is concave on both sides; and is connected so firmly by ligaments to each *condyle*, as to follow the motions of the *condyle*; and so loosely to the *temporal* bone, as readily to change its situation from the cavity to the tubercle, and to return again; while the common ligament of

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the articulation affords space enough for such a change of place backwards and forwards; but, like other ligaments of the joints by *ginglimus*, is strong and short at the sides, to confine the lateral motions.

When, therefore, the teeth of both jaws coincide, the *condyles* are lodged securely in the temporal cavities; but their motions to either side must be confined both by the firmness of the ligaments, and the rising brims which are on each side of the cavities.—When the jaw is brought directly forwards, the condyle and intermediate cartilages descend and advance forwards upon the tubercles.—In this situation, the lateral motions are a little more free than in the former one, from the want of rising brims to stop the condyles.—When the fore-teeth of the lower jaw are moved forwards, and to a side, the condyle of the opposite side is either advanced from the cavity to the tubercle, while the condyle of the same side remains in the cavity; or if both condyles are on the tubercles, when the jaw is moved obliquely to a side, the condyle of the side to which the motion is made slides back from the tubercle to the cavity.—When the mouth is opened by the descent of the lower jaw, the fore-part of it, where the *depressing* muscles are fixed, is drawn backwards, as well as downwards, while resistance is made to the angles moving backwards by the *masseter* and *internal pterygoid* muscles, and at the same time the *external pterygoid* draw the condyles and their moveable cartilages forwards; and therefore, when the mouth is opened, the condyles are carried forwards upon the tubercles, and the axis of motion of the bone is a little above its angles. But in this situation there is less resistance than in any other to the condyles luxating forwards; a disease which seldom happens, except when people are gaping too wide: and therefore the common practice of nurses, who support the jaw of infants when yawning, is reasonable.—In chewing, there is a succession of the motions above described (a).

Here a general remark may be made, That wherever moveable cartilages are found in joints, either the articulated bones are of such a figure, or so joined and fixed by their ligaments, that little motion would be allowed without such cartilages; or else some motions are necessary to the
right

(a) For a more full account of this articulation, vid. *Edinburgh Medical Essays and Observations*, vol. i. art. 11. and vol. iii. art. 13. or N° V. of this COLLECTION.—*Memoires de l'Acad. des Sciences*, 1744.

right use of the member, which the form of the articulation would not otherwise admit of. This will more fully appear after the other joints with such cartilages are described.

In a child born to the full time, the lower jaw is composed of two bones, connected by a thin cartilage in the middle of the chin, which gradually ossifies, and the two bones intimately unite.—In each of these bones there are five or six sockets for teeth, as in the upper jaw.

After I have thus described the incasement of the teeth, the insertion of so many muscles of the tongue and of the *os hyoides*, the connection of the membrane of the tongue to the maxillary bone, and the motions of this bone; it is easy to see, that the lower jaw must be a principal instrument in manducation, deglutition, and speech.

The TEETH are the hard white bodies placed in the sockets of both jaws. Their number is generally sixteen above, and as many below; though some people have more, others have fewer.

The broad thick part of each tooth which appears without the socket, is the *base* or body (*a*).—The smaller processes sunk into the *maxillæ*, are the *roots* or *fangs*; which become gradually smaller towards the end farthest from the base, or are nearly conical, by which the surface of their sides divides the pressure made on the bases, to prevent the soft parts, which are at the small points of the sockets, to be hurt by such pressure.—At the place where the base ends and the roots begin, there is generally a small circular depression, which some call the *neck* or *collar*.

Without the gums the teeth are covered with no membrane, and they are said to have no proper *periosteum* within the sockets: but that is supplied by the reflected membrane of the gums; which, after a good injection, may be evidently seen in a young subject, with the vessels from it penetrating into the substance of the teeth; and it may be discovered in any tooth recently pulled, by macerating it in water (*b*). The adhesion of this membrane to these roots is strengthened by the small furrows observable on them.

Each tooth is composed of its *cortex* or *enamel*, and an internal bony substance. The *cortex* has no cavity or place for marrow; and is so solid and hard, that saws or files can with difficulty make impression on it.

It

(*a*) Corona.

(*b*) Cowper, *Anatom. explicat.* tab. 92. fig. 7. E.

It is thickest upon the base; and gradually, as the roots turn smaller, becomes thinner, but not proportionally to the difference of the size of the base and roots.—The fibres of this enamel are all perpendicular to the internal substance; and are straight on the base, but at the sides are arched with a convex part towards the roots (*a*); which makes the teeth resist the compression of any hard body between the jaws, with less danger of breaking these fibres, than if they had been situated transversely. The spongy sockets in which the teeth are placed, likewise serve better to prevent such an injury, than a more solid base would have done.—Notwithstanding the great hardness of this *cortex*, it is wasted by manducation. Hence the sharp edges of some teeth are blunted and made broad, while the rough surfaces of others are made smooth and flat, as people advance in life.

The bony part of the teeth has its fibres running straight, according to the length of the teeth. When it is exposed to the air, by the breaking or falling off of the hard *cortex*, it soon corrupts: And thence carious teeth are often all hollow within, when a very small hole appears only externally.

The teeth have canals formed in their middle, wherein their nerves and blood-vessels are lodged: Which they certainly need, being constantly wasted by the attrition they are subjected to in manducation, and for their further growth, not only after they first appear, but even in adults; as is evident when a tooth is taken out: for then the opposite one becomes longer, and those on each side of the empty socket turn broader; so that when the jaws are brought together, it is scarce observable where the tooth is wanting (*b*).

The vessels are easily traced so long as they are in the large canal, but can scarce be observed in their distribution from that to the substance of the teeth of adults. Ruysch (*c*) however affirms, that after injection he could trace the arteries into the hardest part of the teeth: And Leewenhoek (*a*) suspected the fibres of the *cortex* to be vessels.—This plentiful supply of vessels must expose the teeth to the same disorders that attack other vascular parts; and such teeth as have the greatest number of vessels

(*a*) Havers Osteolog. Nov. disc. 1.

(*b*) Ingraf. de Tumor. cap. 1. p. 24, 25, 26.

(*c*) Thefaur. 10. n° 27.

(*d*) Arcan. Natur. Continuat. Epist. p. 3.

fels must have the most numerous chances of being seized with these diseases.

Every root of each tooth has such a distinct canal, with vessels and nerves in it. These canals in the teeth with more than one root, come nearer each other as they approach the base of the tooth; and at last are only separated by very thin plates; which being generally incomplete, allow a communication of all the canals; and frequently one common cavity only appears within the base, in which a pulpy substance, composed of nerves and vessels, is lodged. The condition therefore of the nerves here bears a strong analogy to that of the cutaneous nerves which serve for the sensation of touching.

The entry of the canals for these vessels is a small hole placed a little to a side of the extreme point of each root: sometimes, especially in old people, this hole is entirely closed up, and consequently the nerves and blood-vessels are destroyed (a).

The teeth are seen for a considerable time in form of *mucus* contained in a membrane; afterwards a thin cortical plate, and some few osseous layers, appear within the membrane, with a large cavity filled with *mucus* in the middle; and gradually this exterior shell turns thicker, the cavity decreases, the quantity of *mucus* is lessened, and this induration proceeds till all the body is formed; from which the roots are afterwards produced.

In young subjects, different *flamina* or rudiments of teeth are to be observed. Those next the gums hinder ordinarily the deeper seated ones from making their way out; while these prevent the former from sending out roots, or from entering deep into the bony sockets of the jaws; by which they come to be less fixed.

Children are seldom born with teeth; but at two years of age they have twenty; and their number does not increase till they are about seven years old, when the teeth that first made their way through the gums are thrust out by others that have been formed deeper in the jaw, and some more of the teeth begin to discover themselves farther back in the mouth. About fourteen years of age, some more of the first crop are shed, and the number is increased.—This shedding of the teeth is of good use.

(a) De la Histoire de l'Acad. des Sciences, 1699.

use: For if the first had remained, they would have stood at a great distance one from another; because the teeth are too hard in their outer-crust, to increase so fast as the jaws do: whereas both the second layer, and the teeth that come out late, meeting, while they are soft, with a considerable resistance to their growth in length from those situated upon them, necessarily came out broad, and fit to make that close guard to the mouth (*a*) which they now form.

The teeth are joined to the sockets by *gomphosis*, and the gums contribute to fix them there; as is evident by the teeth falling out when the gums are any way destroyed, or made too spongy; as in the *scurvy* or *salivations*: whence some (*b*) class this articulation with the *syssarcosis*.

The uses of the teeth are, to masticate our aliment, and to assist us in the pronunciation of several letters.

Though the teeth so far agree in their structure, yet because of some things wherein they differ, they are generally divided into three classes, viz. *incisores*, *canini*, and *molars*.

The *incisores* (*c*) are the four fore-teeth in each jaw, receiving their name from their office of cutting our aliment; for which they are excellently adapted, being each formed into a sharp-cutting edge at their *base*, by their fore-side turning inwards there, while they are sloped down and hollowed behind (*d*): so that they have the form of wedges; and therefore their power of acting must be considerably increased.—Seeing, in the action of the *incisores*, a particular compression is only necessary, without any lateral motion, they are not so firmly fixed in their sockets as the other teeth are, each only having one short root; but that is broader from before backwards than to either side, to have the greatest strength where it is exposed to the strongest force applied to it (*e*).

The *incisores* of the upper jaw, especially the two middle ones (*f*), are broader and longer generally than those of the under jaw.

In a new-born infant, the outer shell of the body of these teeth is only hardened.—Afterwards, when the *lamina* of two sets are formed, each has

(*a*) *φραγμος*.

(*b*) Drake's Anthropol. book 4. chap. 3.

(*c*) *Γελαστικοί, τομικοί, διχαστηρές, κτινές, τομείς, προσωστικοί, οξεις, risorii, quaterii, primi, primores, anteriores, acuti.*

(*d*) *ολμίσκος*.

(*e*) Lettre sur l'Osteologie, ascribed to Du Verney.

(*f*) *Duales*.

has its own socket; those nearest to the edge of the gums being placed more forward, and the others are lodged farther back within the jaw-bones.

Canini (*a*), from the resemblance to dogs tusks, are one on each side of the *incisores* in each jaw.—The two in the upper jaw are called *eye-teeth*, from the communication of nerves which is said to be betwixt them and the eyes.—The two in the lower jaw are named *angular* or *wike-teeth*, because they support the angles of the mouth.

The *canini* are broader, longer, and stronger, than the *incisores*.—Their bases are formed into a sharp edge, as the *incisores* are; only that the edge rises into a point in the middle.—Each of them has generally but one long root, though sometimes they have two (*b*). The roots are crooked towards the end.—The *canini* of the upper jaw are larger, longer, and with more crooked roots than those of the under jaw.—The form of their base is fit both for piercing and cutting, and the long crooked root of each makes it secure in the socket.

The *canini* of a child are in much the same condition as the *incisores* are.

The *dentes molares*, or *grinders* (*c*), which have got their name because they grind our food, are generally five in each side of each jaw; in all, twenty. Their bases are broader, more scabrous, and with a thinner cortical substance, than the other teeth. They have also more roots; and as these roots generally divaricate from each other, the partitions of the sockets between them bear a large share of the great pressure they suffer, and hinder it from acting on their points (*d*).

The base of the first grinder has an edge pointed in the middle on its outside, resembling the *canini*; from which it slopes inwards till it rises again into a point.—It has generally but one root, which sometimes is long and crooked at its point.

The second *dens molaris* has two points on its base, rising near equally on its out and inside.—It has two roots, either separate or run together,

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but

(*a*) Κυνοδοντις, risorii, fractorii, collaterales, collumellares.

(*b*) Fauchard, Chirurgien Dentiste, chap. 1.

(*c*) Μυλισταί, γομφοί, μύλοι, πλατεῖς, φρασπηρίς, maxillares, mensales, clavales, buccarum.

(*d*) Lettre sur l'Osteologie.

but shorter than the root of the first.—These two anterior grinders are much smaller than the three that are placed farther back in the mouth.

The third and fourth are very broad in their bases, with four or five points standing out; and they have three or more roots.

The fifth, called commonly *dens sapientiæ* (*a*), from its coming through the gums later than the other grinders, has four points on its base, which is not so large as the base of the third and fourth, and its roots are less numerous.

The *incisores* of the upper jaw being broader than those of the lower jaw, make the superior grinders to be placed so much farther back than the lower ones, that when they are brought together, by shutting the mouth, the points of the grinders of the one jaw enter into the depressions of the opposite grinders; and they are all equally applied to each other, notwithstanding the inequality of their surface.

The numerous roots of the *dentes molares* prevent their loosening by the lateral pressure they suffer in grinding; and as the sockets in the upper jaw are more spongy, and the teeth are more liable by their situation to fall out (*a*), the grinders there have more numerous and more separated roots than in the lower jaw (*c*). The number, however, of the roots of the teeth of both jaws is very uncertain; sometimes they are more, sometimes fewer: frequently several roots are joined together; at other times, they are all distinct. The disposition of such as are distinct is also various; for in some the roots stand out straight, in others they separate, and in others again they are crooked inwards. When the roots are united, we can still distinguish them, by remarking the number of small holes at their points, which determine the number of roots each tooth ought to be reckoned to have.

At the time of birth, only two *dentes molares* in each jaw have begun to ossify; and that at little more than the base, which has several sharp points standing out from it.—The temporary grinders are placed more directly upon the internal set than the other two classes are; sometimes
there

(*a*) Σαπρονιστηρες, κραντηρες, οφισγονοι, sensûs, intellectûs, ferotini, ætatem complentes, genuini, moderatores.

(*b*) Galen. de Ossib. cap. 5.

(*c*) Fauchard. Chirurg. Dent. chap. 1.

there is a piece of the bone of the jaws between the two sets; in other children, the two sets have no bone interposed between them.

From what has been said, the answers to the following queries may be given.

Why are children subject to salivation, fever, convulsion, vomiting, purging, &c. when their teeth are breeding or cutting the gums?

Why in children do the *dentes incisores* first cut the gums, the *canini* next, and *molars* last?

Why do children shed their teeth?

Wherefore have these *temporaneous* teeth generally no roots, or very small ones?

Why have these first teeth sometimes roots, and that more frequently in teeth pulled by art than in those which are shedded by nature (*a*)?

Why do these roots frequently come outwards through the gums?

Whence come *butter* or *buck* teeth?

How do these teeth sometimes go into the natural row with the others, after pulling a rotten tooth near them?

How have some people got two rows of teeth in one or both jaws (*b*)?

Why do the teeth of old people loosen, and then drop out entire?

Whence arise the new sets of teeth which several old people obtain (*c*)?

Why are not the gums of toothless old people torn by the hard sockets in chewing?

Why are the teeth insensible when slightly filed or rasped?

How come they to be sensible of heat or cold, to be set on edge by acids, or to give an uneasy sensation when gritty or sandy substances are rubbed between them?

Why does a person who has a pained tooth imagine it longer than any other?

What is the reason of some persons dying convulsed, upon rasping or filing down an overgrown tooth (*d*)?

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(a) Fauchard. Chirurgien-dentiste, p. 7.

(b) Blas. Comment. ad Vesling. Syntagm. cap. 13.

(c) Hoffman. in Van. Horn. Microcosm. p. 38.

(d) Bartholin. Anat. Reformat. lib. 4. cap. 12.

How do the teeth break and moulder away without any pain in some people, and not in others ?

What parts are affected in the tooth-ach ?

What are the causes of the tooth-ach ?

May worms be reckoned among these causes (a) ?

Why are the *dentes molares* most subject to that disease ?

In what different manners ought the several classes of teeth to be extracted when such an operation is necessary ?

Whence proceeds the violent obstinate *hemorrhagy* which sometimes attends the drawing of teeth (b) ?

Why is it more difficult and dangerous to draw the eye-teeth than any other ?

What makes it impossible frequently to draw *grinders* without bringing away part of the jaw-bone with them, or breaking the fangs ?

Why do teeth, soon replaced after being extracted, become again fixed in the sockets (c) ?

According to the division made of the skeleton, we should now proceed to the description of the trunk of the body ; but must first consider a bone, which cannot well be said to belong to either the head or the trunk ; nor is it immediately joined to any other, and therefore is very seldom preserved with skeletons. However, it is generally described by authors after the bones of the face.—In compliance therefore with the prevailing method, I shall next examine the structure of

The OS HYOIDES (d), which is situated horizontally between the root of the tongue and the *larynx*. It is properly enough named *hyoides*, from the resemblance it bears to the *Greek* letter υ ; and may, for a clearer demonstration of its structure, be distinguished into its *body*, *cornua*, and *appendices*.

The

(a) Jacob. in Act. Hafn. vol. v. obs. 107.—Pechlin. Observ. Medic. lib. 2. obs. 36.—Bartholin. Hist. Medic. cent. 3. hist. 96.

(b) Parè, livre 6. chap. 2.—Rolsinc. lib. 2. cap. 27. & 30.—Moebii Fundam. Medicin. cap. 9.—Ephemerid. German. dec. 1. ann. 3. obs. 319.—Fauchard. Chirurg. Dentiste, tom. i. chap. 23. obs. 7.

(c) De la Motte Chirurgie, tom. i. chap. 4. obs. 2.—Fauchard. Chirurgien Dentiste, tom. i. chap. 29.

(d) Hypophyloides, lambdoides, παρασχη, γαρρυγγερον, os gutturis, os linguæ, os morfus Adami, assessor, os laude, bicornis.

The body is the middle broad part, convex before, and hollow behind.—The convex fore-part is divided into two by a ridge, into the middle of which the *mylo-hyoidei*, and into the sides the *stylo-hyoidei*, muscles are inserted.—Above the ridge, the bone is horizontal, but pitted in the middle by the insertion of the two *genio-hyoidei* muscles, and a little hollowed more laterally by the *basio-glossi*.—Below the ridge it is convex, but a little flattened in the middle by the *sterno-hyoidei*, and pitted more externally by the *coraco-hyoidei*.—The concavity behind faces backwards and downwards, to receive the *thyroid* cartilage, when the *larynx* and the *os hyoides* are pulled towards each other by the action of the *sterno-hyoidei* and *hyothyroidei* muscles; and to its upper edge, the ligamentous membranes of the *epiglottis*, tongue, and *thyroid* cartilage, are fixed.

The *cornua* of the (a) *os hyoides* are stretched backwards from each side of its body, where often a small furrow points out the former separation: for in young subjects, the body and *cornua* are not one continued substance as they come afterwards to be in adults.—These *cornua* are not always straight, nor of equal length; their two plain surfaces stand obliquely sloping from above outwards and downwards.—Into the external, the *cerato-glossus* is inserted above, and the *thyro-hyoideus* muscle below; and to the one behind, the ligamentous membrane of the tongue and *larynx* adheres. Each of the *cornua* becomes gradually smaller as it is extended from the base; but ends in a round tubercle, from which a moveable cartilage stands out, which is connected to the upper process of the *cartilago thyroidea*.

Where the body of the *os hyoides* joins on each side with its *cornua*, a small styliform process, called *appendix* (b), rises upwards and backwards, into which the *musculi stylo-hyoidei alteri* and part of the *hyo-glossi* muscles are fixed. From each of them a ligament is sometimes extended to the *styloid* processes of the temporal bones, to keep the *os hyoides* from being drawn too much forwards or downwards. The part of this ligament next to these processes sometimes forms into several cartilages, which afterwards ossify in old people. *Ruyfch* (c) says, that he has seen this ossification.

(a) Crura, latera inferiora.

(b) Crura superiora, latera superiora, ossa graniformia.

(c) *Advers. Anat. dec. 2.*

cation continued as far up as the styloid processes, which were therefore joined to the *os hyoides* by *anchylosis*.

The substance of the *os hyoides* is cellular; but covered with a firm external plate, which is of sufficient strength to bear the actions of so many muscles as are inserted into it.

It is not articulated with any bone of the body, except by means of the muscles and ligaments mentioned.

The use of the *os hyoides* is to serve as a solid lever for the muscles to act with, in raising or depressing the tongue and *larynx*, or in enlarging and diminishing the capacity of the *fauces*.

At birth, this bone is in a cartilaginous state; excepting a small point of bone in the middle of its body, and in each of the *cornua*.—The *appendices* frequently remain cartilaginous many years.

Of the TRUNK.

THE TRUNK consists of the *spine*, *pelvis*, and *thorax*.

The SPINE (*a*) is the long pile of bones extended from the *condyles* of the *occiput* to the end of the rump. It somewhat resembles two unequal pyramids joined in a common base. It is not, however, straight; for its upper part being drawn backwards by strong muscles, it gradually advances forwards, to support the *œsophagus*, vessels of the head, &c. Then it turns backwards, to make place enough for the heart and lungs. It is next bended forwards, to support the *viscera* of the *abdomen*. It afterwards turns backwards, for the enlargement of the *pelvis*. And, lastly, it is reflected forwards, for sustaining the lowest great gut.

The *spine* is commonly divided into *true* and *false vertebræ*; the former constituting the long upper pyramid, which has its base below; while the *false vertebræ* make the shorter lower pyramid, whose base is above.

The TRUE VERTEBRÆ (*b*) are the twenty-four upper bones of the *spine*, on which the several motions of the trunk of our bodies are performed; from which use they have justly got their name.

Each

(a) Παγίς νωτον ακανθα, ιερα συριγξ, σωλην, tergum, hominis carina.

(b) Στροφιεις, σαρκορυγεις, spondyli, ossa orbiculata, ossa vertebrata, verticula.

Each of these *vertebræ* is composed of its body and processes.

The body is the thick spongy fore-part, which is convex before, concave backwards, horizontal and plain in most of them above and below. —Numerous small holes, especially on the fore and back part of their surface, give passage to their vessels, and allow the ligaments to enter their substance. —The edges of the body of each *vertebra* are covered, especially at the fore-part, with a ring of bone firmer and more solid than the substance of the body any where else. These rings seem to be joined to the *vertebræ* in the form of *epiphyses*, but are alledged by some (a) to be the ligaments ossified. They are of great use in preventing the spongy bodies from being broken in the motions of the trunk.

Between the bodies of each two adjoining *vertebræ*, a substance between the nature of ligament and cartilage is interposed; which seems to consist of concentric curve fibres, when it is cut horizontally; but when it is divided perpendicularly, the fibres appear oblique and decussating each other (b). —The outward part of the intervertebral ligaments is the most solid and hard; and they gradually become softer, till they are almost in the form of a glairy liquor in the centre; and therefore these substances were not improperly called *mucous ligaments* by the ancients (c). The external fibrous part of each is capable of being greatly extended, and of being compressed into a very small space, while the middle fluid part is incompressible, or nearly so; and the parts of this ligament between the circumference and centre approach in their properties to either, in proportion to their more solid or more fluid texture. The middle point is therefore a *fulcrum*, or *pivot*, on which the motion of a ball and socket may be made, with such a gradual yielding of the substance of the ligament, in which-ever direction our spines are moved, as saves the body from violent shocks, and their dangerous consequences (d). —This *ligamento-cartilaginous* substance is firmly fixed to the horizontal surfaces of the bodies of the *vertebræ*, to connect them; in which it is assisted by a strong membranous ligament, which lines all their concave

(a) Fallop. Observat. Anatom.

(b) Blancard, Anat. Reform. cap. 32. —Weitbrecht, Syndesmolog. sect. 4. § 14.

(c) Galen. de Usu Part. lib. 12. cap. 16.

(d) Medical Essays and Observations, vol. v. art. 28.

cave surface, and by still a stronger ligament that covers all their anterior convex surface.

We may lay it down as a general rule, notwithstanding some exceptions, That the *bodies* of the *vertebræ* are smaller and more solid above, but as they descend they appear larger and more spongy; and that the cartilages between them are thick, and the surrounding ligaments strong, in proportion to the largeness of the *vertebræ*, and to the quantity of motion they perform: By which disposition, the greater weight is supported on the broadest best secured base, and the middle of our body is allowed a large and secure motion.

From each side of the body of each *vertebra*, a bony bridge is produced backwards and to a side; from the posterior end of which, one slanting process rises, and another descends: the smooth, and what is generally the flattest side of each of these four processes, which are called the *oblique* (*a*), is covered with a smooth cartilage; and the two lower ones of each *vertebra* are fitted to and articulated with the two upper or ascending oblique processes of the *vertebra* below, having their articular ligaments fixed into the rough line round their edges.

From between the oblique processes of each side, the *vertebra* is stretched out laterally into a process that is named *transverse*.

From the back-part of the roots of the two oblique, and of the transverse process of each side, a broad oblique bony plate is extended backwards; where these meet, the seventh process of the *vertebræ* takes its rise, and stands out backwards: This being generally sharp-pointed and narrow-edged, has therefore been called *spinal* process; from which this whole chain of bones has got its name.

Besides the common ligament which lines all the internal surface of the spinal processes, as well as of the bodies, there are particular ligaments that connect the bony bridges and processes of the contiguous *vertebræ* together.

The substance of the processes is considerably stronger and firmer, and has a thicker external plate than the bodies of the *vertebræ* have.

The seven processes form a concavity at their fore-part, which, joined to the one at the back-part of the bodies, makes a great hole; and the
holes

(a) *Articulatorii, minimi.*

holes of all the *vertebræ* form a long large conduit (*a*), for containing the *spinal* marrow.—In the upper and lower edge of each *lateral bridge*, there is a notch. These are so adapted to each other in the contiguous *vertebræ*, as to form a round hole in each side between each two *vertebræ*, through which the nerves that proceed from the *spinal* marrow and its blood-vessels pass.

The articulations, then, of these *true vertebræ* are plainly double: for their bodies are joined by the intervening cartilage above described; and their oblique processes, being tipped with cartilages, are so connected by their ligaments as to allow a small degree of motion to all sides. Hence it is evident, that their centre of motion is altered in different positions of the trunk: For, when we bow forwards, the upper moved part bears entirely on the bodies of the *vertebræ*; if we bend back, the oblique processes support the weight; if we recline to one side, we rest upon the oblique processes of that side and part of the bodies; if we stand erect, all the bodies and oblique processes have their share in our support.

Hence it follows, 1. That because the joints of which the spine is composed are so numerous, the *spinal* marrow, nerves, blood-vessels, &c. are not liable to such compression and over-stretching in the motion of the trunk of the body, as they would otherwise be, since several *vertebræ* must be concerned in every motion of the spine; and therefore a very small curvature is made at the conjunction of any two *vertebræ* (*b*). 2. That an erect posture is the surest and firmest; because the surface of contact of the *fulcra* is largest, and the weight is most perpendicular to them (*c*). 3. That the muscles which move the spine act with greater force in bringing the trunk to an erect posture, than in drawing it to any other: For, in bending forwards, backwards, or to a side, the muscles which perform any of these actions are nearer the centre of motion; consequently the lever with which they act is shorter than when the centre of motion is on the part of the *vertebra* opposite to that where these muscles are inserted; which is the case in raising the trunk. This is extremely necessary; since, in the deflections of the spine from a perpendicular bearing, the weight of the body soon inclines it which way

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we

(*a*) ἡ ἰσὺς σπυγγῆς, σωλην, canalis.

(*b*) Galen de Usu Part. lib. 12. cap. 12.

(*c*) Παρὰ de Olib. pars 2. cap. 3.

we design ; whereas, in raising us erect, this great weight must be more than counteracted. 4. In calculating the force exerted by the muscles which move the spine, we should always make allowance for the action of the cartilages between the *vertebræ*, which, in every motion from an erect posture, must be stretched on one side, and compressed on the other, to both which they resist ; whereas, in raising the trunk, these cartilages assist by their springy force (*a*). 5. We are hence naturally led into the reason of our height of stature increasing in the morning, and diminishing at night (*b*) : for the intermediate cartilages of the *vertebræ* being pressed all day long by the weight of our body, become more compact and thin in the evening ; but when they are relieved from this pressure in the night, they again expand themselves to their former thickness : and seeing the bulk of any part must vary according to the different distension or repletion of the vessels composing it, we may understand how we become taller after a plentiful meal, and decrease after fasting or evacuations (*c*). 6. From the different articulations of the bodies, and oblique processes of the *vertebræ*, and the different strength of the ligaments, it is plain, that they are formed so as to allow much larger motion forwards than backwards ; this last being of much less use, and might be dangerous, by overstretching the large blood-vessels that are contiguous to the bodies of the *vertebræ* (*d*). 7. The intervertebral cartilages shrivelling as they become more solid by age, is the cause why old people generally bow forwards, and cannot raise their bodies to such an erect posture as they had in their youth.

The *true vertebræ* serve to give us an erect posture ; to allow sufficient and secure motion to the head, neck, and trunk of the body ; and to support and defend the bowels and other soft parts.

At the ordinary time of birth, each *vertebra* consists of three bony pieces, connected by cartilages ; to wit, the *body*, which is not fully ossified, and a long crooked bone on each side ; on which we see a small share
of

(*a*) Borelli de Motu Animal. pars 1. schol. ad propof. 58.—Parent. Histoire de l'Acad. des Sciences, 1702.

(*b*) Wasse, Philosoph. Transact. no 383. art. 1.

(*c*) Abbe Fontenu, Histoire de l'Acad. des Sciences, 1725.

(*d*) Galen de Ufu Part. lib. 1. cap. 16.

of the bony bridge, the oblique processes complete, the beginning transverse processes, and the oblique plate, but no spinal process; so that the teguments are in no danger of being hurt by the sharp ends of these spinal processes, while a child is in its bended posture in the womb, nor while it is squeezed in the birth.

From this general mechanism of the spine, an account is easily deduced of all the different preternatural curvatures which the spine is capable of: For if one or more *vertebræ*, or their cartilages, are of unequal thickness in opposite sides, the spine must be reclined over to the thinner side; which now sustaining the greatest share of the weight, must still be more compressed, consequently hindered from extending itself in proportion to the other side, which, being too much freed of its burden, has liberty to enjoy a luxuriant growth. The causes on which such an inequality of thickness in different sides of the *vertebræ* depends may vary: For either it may be owing to an over-distension of the vessels of one side, and from thence a preternatural increase of the thickness of that part; or, which more commonly is the case, it may proceed from an obstruction of the vessels, by which the application of proper nourishment to the bony substance is hindered, whether that obstruction depends on the faulty disposition of the vessels or fluids; or if it is produced by an unequal mechanical pressure, occasioned by a paralytic weakness of the muscles and ligaments, or by a spasmodic over-action of the muscles on any side of the spine, or by people continuing long or putting themselves frequently into any posture declining from the erect one: In all these cases one common effect follows; to wit, the *vertebræ*, or their cartilages, or both, turn thick on that side where the vessels are free, and remain thin on the other side where the vessels are straitened or obstructed.—Whenever any morbid curvature is thus made, a second turn, but in an opposite-direction to the former, must be formed; both because the muscles on the convex side of the spine being stretched, must have a stronger natural contraction to draw the parts to which their ends are fixed; and because the patient makes efforts to keep the centre of gravity of the body perpendicular to its base, that the muscles may be relieved from a constant violent contractile state, which always creates uneasiness and pain.

When once we understand how these crooked spines are produced, there is little difficulty in forming a just prognosis; and a proper method of cure may be easily contrived, which must vary as to the internal medicines, according to the different causes on which the disease depends: But one general indication must be pursued by surgeons; which is, to counteract the bending force, by increasing the compression on the convex part of the curvature, and diminishing it on the concave side. The manner of executing which, in particular cases, must be different, and requires a very accurate examination of the circumstances both of the disease and patient. In many such cases, I have found some simple directions, as to postures in which the patient's body should be kept, of very great advantage.

Though the true *vertebræ* agree in the general structure which I have hitherto described; yet because of several specialities proper to a particular number, they are commonly divided into three classes, viz. *cervical*, *dorsal*, and *lumbar*.

The *cervical* (a) are the seven uppermost *vertebræ*; which are distinguished from the rest by these marks.—Their bodies are smaller and more solid than any others; and flattened on the fore-part, to make way for the *œsophagus*; or rather this flat figure is owing to the pressure of that pipe, and to the action of the *longi colli* and anterior *recti* muscles.—They are also flat behind, where small processes rise, to which the internal ligaments are fixed.—The upper surface of the body of each *vertebra* is made hollow, by a slanting thin process which is raised on each side:—The lower surface is also excavated, but in a different manner; for here the posterior edge is raised a little, and the one before is produced a considerable way.—Hence we see how the cartilages between those bones are firmly connected, and their articulations are secure.

The cartilages between these *vertebræ* are thick, especially at their fore-part; which is one reason why the *vertebræ* advance forward as they descend, and have larger motion.

The oblique processes of these bones of the neck more justly deserve that name than those of any other *vertebræ*. They are situated slanting; the upper ones having their smooth and almost flat surfaces facing obliquely

(a) Τραχηλν, αυχης, colli.

liquely backwards and upwards, while the inferior oblique processes have these surfaces facing obliquely forwards and downwards.

The transverse processes of these *vertebræ* are framed in a different manner from those of any other bones of the spine: For besides the common transverse process rising from between the oblique processes of each side, there is a second one that comes out from the side of the body of each *vertebra*; and these two processes, after leaving a circular hole for the passage of the cervical artery and vein, unite, and are considerably hollowed at their upper part, with rising sides, to protect the nerves that pass in the hollow; and at last each side terminates in an obtuse point, for the insertion of muscles.

The spinal processes of these cervical bones stand nearly straight backwards; are shorter than those of any other *vertebræ*; and are forked or double at their ends, and hence allow a more convenient insertion to muscles.

The thick cartilages between the bodies of these *cervical vertebrae*, the obliquity of their *oblique* processes, and the shortness and horizontal situation of their *spinal* processes, all conspire to allow them large motion.

The holes between the bony cross bridges, for the passage of the nerves from the *spinal marrow*, have their largest share formed in the lowest of the two *vertebræ*, to which they are common.

So far most of the cervical *vertebræ* agree; but they have some particular differences, which oblige us to consider them separately.

The first, from its use of supporting the head, has the name of *atlas* (a); and is also called *epistrophe*, from the motion it performs on the second.

The *atlas*, contrary to all the other *vertebræ* of the spine, has no body; but instead of it, there is a bony arch.—In the convex fore-part of which a small rising appears, where the *musculi longi colli* are inserted; and on each side of this protuberance a small cavity may be observed, where the *recti interni minores* take their rise.—The upper and lower parts of the arch are rough and unequal, where the ligaments that connect this *vertebra* to the *os occipitis*, and to the second *vertebra*, are fixed.—The back-part of the arch is concave, smooth, and covered with a cartilage, in a recent subject, to receive the tooth-like process of the second *vertebra*.—

Im

In a first *vertebra*, from which the second has been separated, this hollow makes the passage for the *spinal* marrow to seem much larger than it really is. On each side of it a small rough sinuosity may be remarked, where the ligaments going to the sides of the tooth-like process of the following *vertebra* are fastened; and on each side a small rough protuberance and depression is observable, where the transverse ligament, which secures the tooth-like process in the sinuosity, is fixed, and hinders that process from injuring the *medulla spinalis* in the flexions of the head.

The *atlas* has as little spinal process as body; but instead thereof, there is a large bony arch, that the muscles which pass over this *vertebra* at that place might not be hurt in extending the head. On the back and upper part of this arch there are two depressions, where the *recti postici minores* take their rise; and at the lower part are two other sinuosities, into which the ligaments which connect this bone to the following one are fixed.

The superior oblique processes of this *atlas* are large, oblong, hollow, and more horizontal than in any other *vertebra*.—They rise more in their external than internal brim; by which their articulations with the *condyloid* processes of the *os occipitis* are firmer.—Under the external edge of each of these oblique processes, is the *fossa*, or deep open channel, in which the vertebral arteries make the circular turn, as they are about to enter the great *foramen* of the occipital bone, and where the tenth pair of nerves goes out.—In several bodies I have seen this *fossa* covered with bone.—The inferior oblique processes, extending from within outwards and downwards, are large, concave, and circular. So that this *vertebra*, contrary to the other fix, receives the bones with which it is articulated both above and below.

The transverse processes here are not much hollowed or forked; but are longer and larger than those of any other *vertebra* of the neck, for the origin and insertion of several muscles; of which those that serve to move this *vertebra* on the second have a considerable lever to act with, because of the distance of their insertion from the *axis* of revolution.

The hole for the *spinal marrow* is larger in this than in any other *vertebra*, not only on account of the *marrow* being largest here, but also to prevent its being hurt by the motions of this *vertebra* on the second one.

—This

—This large hole, and the long transverse processes, make this the broadest *vertebra* of the neck.

The *condyles* of the *os occipitis* move forwards and backwards in the superior oblique processes of this *vertebra* : but from the figure of the bones forming these joints, it appears, that very little motion can here be allowed to either side; and there must be still less circular motion.

In new-born children, this *vertebra* has only the two lateral pieces ossified; the arch which it has at its fore-part, instead of a body, being cartilaginous.

The second *vertebra colli* is called *dentata*, from the tooth-like process on the upper part of its body. Some authors call it *epistrophe*; but improperly, since this designation is only applicable to the first, which moves on this as on an axis.

The body of this *vertebra* is somewhat of a pyramidal figure, being large, and produced downwards, especially at its fore-side, to enter into a hollow of the *vertebra* below; while the upper part has a square process with a small point standing out from it. This it is that is imagined to resemble a tooth (*a*), and has given name to the *vertebra*.—The side of this process, on which the hollow of the anterior arch of the first *vertebra* plays, is convex, smooth, and covered with a cartilage; and it is of the same form behind for the ligament, which is extended transversely from one rough protuberance of the first *vertebra* to the other, and is cartilaginous in the middle, to move on it.—A ligament likewise goes out in an oblique transverse direction from each side of the *processus dentatus*, to be fixed at its other end to the first *vertebra*, and to the occipital bone; and another ligament rises up from near the point of the process to the *os occipitis*.

The superior oblique processes of this *vertebra dentata* are large, circular, very nearly in an horizontal position, and slightly convex, to be adapted to the inferior oblique processes of the first *vertebra*.—A moveable cartilage is said by some authors to be interposed between these oblique processes of the first and second *vertebra*; but I could never find it.—The inferior oblique processes of this *vertebra dentata* answer exactly to the description given of those common to all the cervical *vertebræ*.

The

(a) Conoides, pyrenoides, odontoides.

The transverse processes of the *vertebra dentata* are short, very little hollowed at their upper part, and not forked at their ends; and the canals through which the cervical arteries pass, are reflected outwards about the middle substance of each process, so that the course of these vessels may be directed towards the transverse processes of the first *vertebra*.—Had this curvature of the arteries been made in a part so moveable as the neck is, while they were not defended by a bone, and fixed to that bone, scarce a motion could have been performed without the utmost hazard of compression, and a stop put to the course of the liquids, with all its train of bad consequences. Hence we observe this same mechanism several times made use of, when there is any occasion for a sudden curvature of a large artery. This is the third remarkable instance of it we have seen. The first was the passage of the *carotids* through the *temporal* bones; and the second was that lately described in the vertebral arteries, turning round the oblique processes of the first *vertebra*, to come at the great hole of the occipital bone.

The spinal process of this *vertebra dentata* is thick, strong, and short, to give sufficient origin to the *musculi recti majores* and *obliqui inferiores*, and to prevent the contusion of these and other muscles in pulling the head back.

This second *vertebra* consists, at the birth, of four bony pieces: For besides the three which I already mentioned as common to all the *vertebræ*, the tooth-like process of this bone is begun at this time to be ossified in its middle, and is joined as an appendix to the body of the bone.—Left this appendix be bended or displaced, nurses ought to keep the heads of new-born children from falling too far backwards, by *stay-bands*, or some such means, till the muscles attain strength sufficient to prevent that dangerous motion.

When we are acquainted with the structure and articulations of the first and second *vertebræ*, and know exactly the strength and connection of their ligaments, there is no difficulty in understanding the motions that are performed upon or by the first; though this subject was formerly matter of hot dispute among some of the greatest anatomists (a). It is none of my purpose at present to enter into a detail of the reasons advanced

(a) See Eustach. de Motu Capitis.

vanced by either party; but to explain the fact, as any one may see it who will remove the muscles, which, in a recent subject, hinder the view of these two joints, and then will turn the head into all the different positions it is capable of. The head may then be seen to move forwards and backwards on the first *vertebra*, as was already said, while the *atlas* performs the *circumgyratio* upon the second *vertebra*; the inferior oblique processes of the first *vertebra* shuffling easily in a circular way on the superior oblique processes of the second, and its body or anterior arch having a rotation on the tooth-like process, by which the perpendicular ligament that is sent from the point of the tooth-like process to the occipital bone is twisted, while the lateral ligaments that fix the *processus dentatus* to the sides of the first *vertebra*, and to the *os occipitis*, are very differently affected; for the one upon the side towards which the face is turned by the *circumgyratio* is much shortened and lax, while the opposite one is stretched and made tense, and, yielding at last no more, prevents the head from turning any farther round on this *axis*. So that these lateral ligaments are the proper *moderators* of the *circumgyratio* of the head here; which must be larger or smaller, as these ligaments are weaker or stronger, longer or shorter, and more or less capable of being stretched. Besides the revolution on this *axis*, the first *vertebra* can move a small way to either side; but is prevented from moving backwards and forwards by its anterior arch, and by the cross ligament, which are both closely applied to the tooth-like process. Motion forwards here would have been of very bad consequence, as it would have brought the beginning of the *spinal* marrow upon the point of the tooth-like process.

The rotatory motion of the head is of great use to us on many accounts, by allowing us to apply quickly our organs of the senses to objects: and the *axis* of rotation was altogether proper to be at this place; for if it had been at a greater distance from the head, the weight of the head, if it had at any time been removed from a perpendicular bearing to the small very moveable joint, and thereby had acquired a long lever, would have broke the ligaments at every turn inconsiderately performed, or these ligaments must have been formed much stronger than could have been connected to such small bones. Neither could this circular motion be performed on the first *vertebra* without danger; because the immove-

able part of the *medulla oblongata* is so near, that at each large turn, the beginning of the *spinal* marrow would have been in danger of being twisted, and of suffering by the compression this would have made on its tender fibrils.

It is necessary to observe, that the *lateral* or *moderator* ligaments confine so much the motion of the first *vertebra* upon the second, that tho' this joint may serve us on several occasions, yet we are often obliged to turn our faces farther round than could be done by this joint alone, without the greatest danger of twisting the spinal marrow too much, and also of luxating the oblique processes: therefore, in large turns of this kind, the rotation is assisted by all the *vertebræ* of the neck and loins; and if this is not sufficient, we employ most of the joints of the lower extremities.—This combination of a great many joints towards the performance of one motion, is also to be observed in several other parts of the body; notwithstanding such motions being generally said to be performed by some single joint only.

The third *vertebra* of the neck is by some called *axis*; but this name is applied to it with much less reason than to the second.—This third, and the three below, have nothing particular in their structure; but all their parts come under the general description formerly given, each of them being larger as they descend.

The seventh (*a*) *vertebra* of the neck is near to the form of those of the back, having the upper and lower surfaces of its body less hollow than the others.—The oblique processes are more perpendicular:—neither spinal nor transverse processes are forked.—This seventh and the sixth *vertebra* of the neck have the hole in each of their transverse processes more frequently divided by a small cross bridge, that goes between the cervical vein and artery, than any of the other *vertebræ*.

The twelve *dorsal* (*b*) may be distinguished from the other *vertebræ* of the spine by the following marks.

Their bodies are of a middle size, betwixt those of the neck and loins: they are more convex before than either of the other two sorts; and are flattened laterally by the pressure of the ribs, which are inserted into small cavities formed in their sides. This flattening on their sides, which makes
the

(*a*) Atlas quibusdam, maxima, magna vertebra, prominens.

(*b*) Θωρακος, μεταρσεων, γατρον, υποτραχηλίου, antisterni, pectoris, tergi.

the figure of these *vertebræ* almost an half oval, is of good use; as it affords a firm articulation to the ribs, allows the *trachea arteria* to divide at a small angle, and the other large vessels to run secure from the action of the vital organs.—These bodies are more concave behind than any of the other two classes:—their upper and lower surfaces are horizontal.

The cartilages interposed between the bodies of these *vertebræ* are thinner than in any other of the *true vertebræ*; and contribute to the concavity of the spine in the thorax, by being thinnest at their fore-part.

The *oblique* processes are placed almost perpendicular; the upper ones slanting but a little forwards, and the lower ones slanting as much backwards.—They have not as much convexity or concavity as is worth remarking.—Between the oblique processes of opposite sides, several sharp processes stand out from the upper and lower parts of the plates which join to form the spinal process; into these sharp processes strong ligaments are fixed for connecting the *vertebræ*.

The *transverse* processes of the *dorsal vertebræ* are long, thicker at their ends than in the middle, and turned obliquely backwards; which may be owing to the pressure of the ribs, the tubercles of which are inserted into a depression near the end of these processes.

The *spinal* processes are long, small pointed, and sloping downwards and backwards; from their upper and back part a ridge rises, which is received by a small channel in the fore-part of the spinal process immediately above, which is here connected to it by a ligament.

The *conduit* of the *spinal* marrow is here more circular; but, corresponding to the size of that cord, is smaller than in any of the other *vertebræ*; and a larger share of the holes in the bony bridges, for the transmission of the nerves, is formed in the *vertebra* above than in the one below.

The connection of the *dorsal vertebræ* to the ribs, the thinness of their cartilages, the erect situation of the oblique processes, the length, sloping, and connection of the spinal processes, all contribute to restrain these *vertebræ* from such motion, which might disturb the actions of the heart and lungs; and, in consequence of the little motion allowed here, the *intervertebral* cartilages sooner shrivel, by becoming more solid: and therefore the first remarkable curvature of the spine observed as people advance

to old age, is in the least stretched *vertebræ* of the back; or old people first become round-shouldered.

The bodies of the four uppermost *dorsal vertebræ* deviate from the rule of the *vertebræ* becoming larger as they descend: for the first of the four is the largest; and the other three below gradually become smaller, to allow the *trachea* and large vessels to divide at smaller angles.

The two uppermost *vertebræ* of the back, instead of being very prominent forwards, are flattened by the action of the *musculi longi colli* and *recti majores*.

The proportional size of the two little depressions in the body of each *vertebra* for receiving the heads of the ribs, seems to vary in the following manner; the depression on the upper edge of each *vertebra* decreases as far down as the fourth, and after that increases.

The transverse processes are longer in each lower *vertebra* to the seventh or eighth, with their smooth surfaces, for the tubercles of the ribs, facing gradually more downwards; but afterwards, as they descend, they become shorter, and the smooth surfaces are directed more upwards.

The spinous processes of the *vertebræ* of the back become gradually longer and more slanting from the first, as far down as the eighth or ninth *vertebra*; from which they manifestly turn shorter and more erect.

The first (*a*) *vertebra*, besides an oblong hollow in its lower edge, that assists in forming the cavity wherein the second rib is received, has the whole cavity for the head of the first rib formed in it.

The second has the name of *axillary* (*b*), without any thing particular in its structure.

The eleventh (*c*) often has the whole cavity for the eleventh rib in its body, and wants the smooth surface on each transverse process.

The twelfth (*d*) always receives the whole head of the last rib; and has no smooth surface on its transverse processes, which are very short.—The smooth surfaces of its inferior oblique processes face outwards as the *lumbar* do.—And we may say in general, that the upper *vertebræ* of the back lose gradually their resemblance to those of the neck, and the lower ones come nearer to the figure of the *lumbar*.

The

(*a*) Λοφία, gutturalis.

(*b*) Μασχαλίστηρ.

(*c*) Αρρεπνή, in neutram partem inclinans.

(*d*) Διασωστής, præcingens.

The articulation of the *vertebræ* of the back with the ribs shall be more particularly considered after the ribs are described. Only it may be proper now to remark, that the ligaments which serve that articulation assist in connecting the *vertebræ*.

The lowest order of the *true vertebræ* is the *lumbar* (a), which are five bones, that may be distinguished from any others by these marks: 1. Their bodies, though of a circular form at their fore-part, are somewhat oblong from one side to the other; which may be occasioned by the pressure of the large vessels, the *aorta* and *cava*, and of the *viscera*. The *epiphyses* on their edges are larger; and therefore the upper and lower surfaces of their bodies are more concave than in the *vertebræ* of the back. 2. The cartilages between these *vertebræ* are much the thickest of any; and render the spine convex within the *abdomen*, by their greatest thickness being at their fore-part. 3. The oblique processes are strong and deep; those in opposite sides being almost placed in parallel planes; the superior, which are concave, facing inwards, and the convex inferior ones facing outwards: and therefore each of these *vertebræ* receives the one above it, and is received by the one below; which is not so evident in the other two classes already described. 4. Their transverse processes are small, long, and almost erect, for allowing large motion to each bone, and sufficient insertion to muscles, and for supporting and defending the internal parts. 5. Betwixt the roots of the superior oblique and transverse processes, a small protuberance may be observed, where some of the muscles that raise the trunk of the body are inserted. 6. Their spinal processes are strong, straight, and horizontal, with broad flat sides, and a narrow edge above and below; this last being depressed on each side by muscles: and at the root of these edges we see rough surfaces for fixing the ligaments. 7. The canal for the numerous cords, called *cauda equina*, into which the spinal marrow divides, is rather larger in these bones than what contains that *marrow* in the *vertebræ* of the back. 8. The holes for the passage of the nerves are more equally formed out of both the contiguous *vertebræ* than in the other classes; the upper one furnishes, however, the larger share of each hole.

The thick cartilages between these *lumbar vertebræ*, their deep oblique
processes,

(a) ὀστέον ἰξυός, φλοιῶν, *renum, lumborum*.

processes, and their erect spinal processes, are all fit for allowing large motion: though it is not so great as what is performed in the neck; which appears from comparing the arches which the head describes when moving on the neck or the loins only.

The *lumbar vertebrae*, as they descend, have their oblique processes at a greater distance from each other, and facing more backwards and forwards.

Both transverse and spinal processes of the middlemost *vertebrae* of the loins are longest and thickest; in the *vertebrae* above and below they are less. So that these processes of the first (*a*) and fifth (*b*) are the least, to prevent their striking on the ribs or *ossa ilium*, or their bruising the muscles in the motions of the spine.

The *epiphyses* round the edges of the bodies of the *lumbar vertebrae* are most raised in the two lowest; which consequently make them appear hollower in the middle than the others are.

The body of the fifth *vertebra* is rather thinner than that of the fourth. The spinal process of this fifth is smaller, and the oblique processes face more backwards and forwards than in any other *lumbar vertebra*.

After considering the structure of the particular *vertebrae*, and their mutual connection, we may observe a solicitous care taken that they shall not be disjoined but with great difficulty: for, besides being connected by strong ligaments proportioned to the forces which are to be resisted, their bodies either enter so into each other, as to prevent their being displaced any way, as in the *vertebrae* of the neck; or they are propped on all sides, as those of the *back* are by the ribs; or their surfaces of contact are so broad, as to render the separation almost impracticable, as in the *loins*; while the depth and articulation of the oblique processes are exactly proportioned to the quantity of motion which the other parts of the bones allow, or the muscles can perform: yet as these oblique processes are small, and therefore not capable of so secure a conjunction as the larger bodies, they may sooner yield to a disjoining force; but then their dislocation is not of near so bad consequence as the separation of the bodies would be. For by the oblique processes being dislocated, the muscles, ligaments, and *spinal* marrow, are indeed stretched; but this
marrow

(*a*) Νισγητης, renalis.

(*b*) Ασχλητης, fulciens.

marrow must be compressed, or entirely destroyed, when the body of the *vertebra* is removed out of its place.

The FALSE VERTEBRÆ compose the under pyramid of the *spine*. They are distinguished from the bones already described justly enough by this epithet of *false*: because though each bone into which they can be divided in young people resembles the *true vertebra* in figure, yet none of them contribute to the motion of the trunk of the body; they being intimately united to each other in adults, except at their lower part, where they are moveable; whence they are commonly divided into two bones, *os sacrum* and *coccygis*.

OS SACRUM (*a*) is so called, from being offered in sacrifice by the ancients, or rather because of its largeness in respect of the other *vertebræ*. This bone is of an irregular triangular shape; broad above, narrow below, convex behind for the advantageous origin of the muscles that move the *spine* and thigh backwards, and concave before for enlarging the cavity of the *pelvis*.—Four transverse lines, of a colour different from the rest of the bone, which are seen on its fore-part, are the marks of division of the five different bones of which it consists in young persons.

The fore-part of the *os sacrum*, analogous to the bodies of the *true vertebrae*, is smooth and flat, to allow a larger space for the contained bowels, without any danger of hurting them; or this flat figure may be owing to the equal pressure of these bowels, particularly of the last gut.—The back-part of it is almost straight, without so large a cavity as the *vertebræ* have; because the spinal marrow, now separated into the *cauda equina*, is small.—The bridges between the bodies and processes of this bone, are much thicker, and in proportion shorter, than in the former class of bones.—The strength of these cross bridges is very remarkable in the three upper bones; and is well proportioned to the incumbent weight of the trunk of the body, which these bridges sustain in a transverse, consequently an unfavourable situation, when the body is erect.

There are only two oblique processes of the *os sacrum*; one standing out on each side from the upper part of the first bone.—Their plain erect surfaces face backwards, and are articulated with the inferior oblique processes of the last *vertebra* of the loins, to which each of these processes

is.

(a) ἱερον, σπονδυλος μεγας, Hippocrat. υποσπονδυλον, Oribas. πλατυ, latum, *os clunium*, *clavium*.

is connected by a strong ligament, which rises from a scabrous cavity round their roots, where mucilaginous glands are also lodged.—Instead of the other oblique processes of this bone, four rough tubercles are to be seen on each side of its surface behind, from which the *musculus sacer* has its origin.

The transverse processes here are all grown together into one large strong oblong process on each side; which, so far as it answers to the first three bones, is very thick, and divided into two irregular cavities, by a long perpendicular ridge.—The foremost of the two cavities has commonly a thin cartilaginous skin covering it in the recent subject, and is adapted to the unequal protuberance of the *os ilium*, and a strong ligament connects the circumference of these surfaces of the two bones.—The cavity behind is divided by a transverse ridge into two, where strong ligamentous strings, that go from this bone to the *os ilium*, with a cellular substance containing *mucus*, are lodged.

The transverse processes of the two last bones of the *os sacrum* are much smaller than the former.—At their back-part, near their edge, a knob and oblong flat surface give rise to two strong ligaments which are extended to the *os ischium*; and are therefore called *sacro-sciatic*.

The spinal processes of the three uppermost bones of the *os sacrum* appear short, sharp, and almost erect, while the two lower ones are open behind; and sometimes a little knob is to be seen on the fourth, though generally it is bifurcated, without the two legs meeting into a spine; in which condition also the first is often to be seen; and sometimes none of them meet, but leave a *sinus*, or rather *fossa*, instead of a canal (a). The *musculus latissimus* and *longissimus dorsi*, *sacro-lumbalis*, and *glutæus maximus*, have part of their origins from these spinal processes.

The canal between the bodies and processes of this bone, for the *cauda equina*, is triangular; and becomes smaller as it descends, as the *cauda* also does.—Below the third bone, this passage is no more a complete bony canal, but is open behind; and is only there defended by a strong ligamentous membrane stretched over it, which, with the muscles that cover it, and are very prominent on each side, is a sufficient defence for the bundle of nerves within.

At

(a) Verheyen, Anat. tract. 5. cap. 9.—Sue Trad. d'Osteol. p. 127.

At the root of each oblique process of this bone, the notch is conspicuous; by which, and such another in the last *vertebra* of the loins, a passage is left for the twenty-fourth spinal nerve; and, in viewing the *os sacrum*, either before or behind, four large holes appear in each side, in much the same height as where the marks of the union of its several bones remain. Some of the largest nerves of the body pass through the anterior holes; and superficial grooves running outwards from them in different directions, shew the course of these nerves.—From the intervals of these grooves, the *pyriformis* muscle chiefly rises.—The holes in the back-part of the bone are covered by membranes which allow small nerves to pass through them.—The two uppermost of these holes, especially on the fore-side, are the largest; and, as the bone descends, the holes turn smaller. Sometimes a notch is only formed at the lower part in each side of this bone; and, in other subjects, there is a hole common to it and the *os coccygis*, through which the twenty-ninth pair of spinal nerves passes; and frequently a bony bridge is formed on the back-part of each side by a process sent up from the back-part of the *os coccygis*, and joined to the little knobs which the last bone of the *os sacrum* has instead of a spinal process. Under this bridge or *jugum*, the twenty-ninth pair of spinal nerves runs in its course to the common holes just now described.

The upper part of the body of the first bone resembles the *vertebræ* of the loins; but the small fifth bone is oblong transversely, and hollow in the middle of its lower surface.

The substance of the *os sacrum* is very spongy, without any considerable solid external plates, and is lighter proportionally to its bulk than any other bone in the body; but is secured from injuries by the thick muscles that cover it behind, and by the strong ligamentous membranes that closely adhere to it.—As this is one of the most remarkable instances of this sort of defence afforded a soft weak bone, we may make the general observation, That wherever we meet with such a bone, one or other, or both these defences, are made use of; the first to ward off injuries, and the second to keep the substance of the bone from yielding too easily.

This bone is articulated above to the last *vertebra* of the loins, in the

manner that the *lumbar vertebræ* are joined ; and therefore the same motions may be performed here.—The articulation of the lower part of the *os sacrum* to the *os coccygis* seems well enough adapted for allowing considerable motion to this last bone, was it not much confined by ligaments. Laterally, the *os sacrum* is joined to the *ossa ilium* by an immoveable *synchondrosis*, or what almost deserves the name of a future: for the cartilaginous crust on the surface of the bones is very thin, and both their surfaces are so scabrous and unequal as to be indented into each other ; which makes such a strong connection, that great force is required to separate them, after all the muscles and ligaments are cut.—Frequently the two bones grow together in old subjects.

The uses of the *os sacrum* are, to serve as the common base and support of the trunk of the body, to guard the nerves proceeding from the end of the spinal marrow, to defend the back-part of the *pelvis*, and to afford sufficient origin to the muscles which move the trunk and thigh.

The bones that compose the *os sacrum* of infants have their bodies separated from each other by a thick cartilage ; and, in the same manner as the *true vertebræ*, each of them consists of a body and two lateral parts, connected together by cartilages ; the ends of the plates seldom being contiguous behind.

Os coccygis (a), or *rump-bone*, is that triangular chain of bones depending from the *os sacrum* ; each bone becoming smaller as they descend, till the last ends almost in a point. The *os coccygis* is convex behind, and concave before ; from which crooked pyramidal figure, which was thought to resemble a cuckow's beak, it has got its name.

This bone consists of four pieces, in people of middle age : in children, very near the whole of it is cartilage : in old subjects, all the bones are united, and become frequently one continued bone with the *os sacrum*.

The highest of the four bones is the largest, with shoulders extended farther to each side than the end of the *os sacrum*. Which enlargement should, in my opinion, serve as a distinguishing mark to fix the limits of either bone ; and therefore should take away all dispute about reckoning the number of bones, of which one or other of these two parts of the *false vertebræ* is composed : which dispute must still be kept up, so long as the

(a) ὀστέον ὀπίσθεν, caudæ os, spondylium, os cuculi.

the numbering five or six bones in the *os sacrum* depends upon the uncertain accident of this broad-shouldered little bone being united to or separated from it.—The upper surface of this bone is a little hollow.—From the back of that bulbous part called its *shoulders*, a process often rises up on each side, to join with the bifurcated spine of the fourth and fifth bones of the *os sacrum*, to form the bony bridge mentioned in the description of the *os sacrum*.—Sometimes these shoulders are joined to the sides of the fifth bone of the *os sacrum*, to form the hole in each side common to these two bones, for the passage of the twenty-ninth pair of spinal nerves.—Immediately below the shoulders of the *os coccygis*, a notch may be remarked on each side, where the thirtieth pair of the spinal nerves passes.—The lower end of this bone is formed into a small head, which very often is hollow in the middle.

The three lower bones gradually become smaller, and are spongy; but are strengthened by a strong ligament which covers and connects them.—Their ends, by which they are articulated, are formed in the same manner as those of the first bone are.

Between each of these four bones of young subjects, a cartilage is interposed; therefore their articulation is analogous to that of the bodies of the *vertebræ* of the neck: For, as has been often above remarked, the lower end of the *os sacrum*, and of each of the three superior bones of the *os coccygis*, has a small depression in the middle; and the upper part of all the bones of the *os coccygis* is a little concave, and consequently the interposed cartilages are thickest in the middle, to fill up both cavities; by which they connect the bones more firmly.—When the cartilages ossify, the upper end of each bone is formed into a cavity, exactly adapted to the protuberant lower end of the bone immediately above.—From this sort of articulation, it is evident, that, unless when these bones grow together, all of them are capable of motion; of which the first and second, especially this last, enjoys the largest share.

The lower end of the fourth bone terminates in a rough point, to which a cartilage is appended.

To the sides of these bones of the *os coccygis*, the *coccygæi* muscles (*a*), and part of the *levator ani*, and of the *glutæi maxim.*, are fixed.

U 2

The

(a) Douglas, Myograph. cap. 40.—Eustach. tab. 36. n° 45. 20.

The substance of these bones is very spongy, and in children cartilaginous; there being only a part of the first bone ossified in a new-born infant.—Since, therefore, the *intestinum rectum* of children is not so firmly supported as it is in *adults*, this may be one reason why they are more subject to a *proidentia ani* than old people (*a*).

From the description of this bone, we see how little it resembles the *vertebræ*; since it seldom has processes, never has any cavity for the *spinal* marrow, nor holes for the passage of nerves.—Its connection hinders it from being moved to either side; and its motion backwards and forwards is much confined: yet, as its ligaments can be stretched by a considerable force, it is a great advantage in the excretion of the *fæces alvinæ*, and much more in child-bearing, that this bone should remain moveable; and the right management of it, in delivering women, may be of great benefit to them (*b*).—The mobility of the *os coccygis* diminishing as people advance in age, especially when its ligaments and cartilages have not been kept flexible by being stretched, is probably one reason why the women, who are old maids before they marry, have generally hard labour in child-bed.

The *os coccygis* serves to sustain the *intestinum rectum*: and, in order to perform this office more effectually, it is made to turn with a curve forwards; by which also the bone itself, as well as the muscles and teguments, is preserved from any injury when we sit with our body reclined back.

The second part of the trunk of the skeleton, the PELVIS, is the cylindrical cavity at the lower part of the *abdomen*, formed by the *os sacrum*, *os coccygis*, and *ossa innominata*; which last, therefore, fall now in course to be examined.

Though the name of OSSA INNOMINATA (*c*) contributes nothing to the knowledge of their situation, structure, or office, yet they have been so long and universally known by it, that there is no occasion for changing it.—They are two large broad bones, which form the fore-part and sides of the *pelvis*, and the lower part of the sides of the *abdomen*.—In children,

(a) Spigel. de Humani Corp. Fabric. lib. 2. cap. 22.—Paaw de Ossib. pars 2. cap. 3.

(b) Paaw, *ibid.*—Deventer, Operat. Chirurg. cap. 27.

(c) Σκελετων, προσηυσις, sacro conjuncta.

children, each of these bones is evidently divided into three; which are afterwards so intimately united, that scarce the least mark of their former separation remains: This notwithstanding, they are described as consisting each of three bones, to wit, the *os ilium*, *ischium*, and *pubis*; which I shall first describe separately, and then shall consider what is common to any two of them, or to all three.

OS ILIUM (*a*), or *haunch bone*, is situated highest of the three, and reaches as far down as one third of the great cavity into which the head of the thigh-bone is received.

The external side of this bone is unequally convex, and is called its *dorsum*;—the internal concave surface is by some (but improperly) named its *costa*.—The semicircular edge at the highest part of this bone, which is tipped with a cartilage in the recent subject, is named the *spine*, into which the external or descending oblique muscle of the *abdomen* is inserted; and from it the internal ascending oblique, and the transverse muscles of the belly, with the *glutæus maximus*, *quadratus lumborum*, and *latissimus dorsi*, have their origin. Some (*b*) are of opinion, that it is only the tendinous crust of all these muscles, and not a cartilage, as commonly alleged, that covers this bony edge.—The ends of the spine are more prominent than the surface of the bone below them; therefore are reckoned processes.—From the anterior spinal process, the *sartorius* and *fascialis* muscles have their rise; and the outer end of the doubled tendon of the external oblique muscle of the *abdomen*, commonly called *Fallopian's* or *Poupart's* ligament, is fixed to it.—The inside of the posterior spinal process, and of part of the spine forward from that, is made flat and rough where the *sacro-lumbalis* and *longissimus dorsi* rise; and to its outside ligaments, extended to the *os sacrum* and transverse processes of the fifth and fourth *vertebræ* of the loins, are fixed (*c*).—Below the anterior spinal process another protuberance stands out, which, by its situation, may be distinguished from the former, by adding the epithet of *inferior*, where the *musculus rectus tibiæ* has its origin (*d*).—Betwixt these two anterior processes

(*a*) λαγον, κενον, scaphium, lumbare, clunium, clavium, anchas.

(*b*) Winslow, Exposition Anatomique du Corps Humain, traité des Os Frais, § 96.

(*c*) Weitbrecht, Syndesmolog. sect. 4. § 39, 40, 46, 47.

(*d*) Baker, Curf. Osteolog. demonstr. 3.

processes, the bone is hollowed where the beginning of the *sartorius* muscle is lodged.—Below the posterior spinal process, a second protuberance of the edge of this bone is in like manner observable, which is closely applied to the *os sacrum*.—Under this last process a considerable large niche is observable in the *os ilium*; between the sides of which and the strong ligament that is stretched over from the *os sacrum* to the sharp-pointed process of the *os ischium* of the recent subject, a large hole is formed, through which the *musculus pyriformis*, the great sciatic nerve, and the posterior crural vessels, pass, and are protected from compression.

The external broad side or *dorsum* of the *os ilium* is a little hollow towards the fore-part; farther back, it is as much raised; then is considerably concave; and, lastly, it is convex. These inequalities are occasioned by the actions of the muscles that are situated on this surface. From behind the uppermost of the two anterior spinal processes, in such bones as are strongly marked by the muscles, a semicircular ridge is extended to the hollow passage of the sciatic nerve. Between the spine and this ridge the *glutæus medius* takes its rise. Immediately from above the lowest of the anterior spinal processes, a second ridge is stretched to the niche. Between this and the former ridge the *glutæus minimus* has its origin. On the outside of the posterior spinal processes, the *dorsum* of the *os ilium* is flat and rough, where part of the *musculus glutæus maximus* and *pyriformis* rises. The lowest part of this bone is the thickest; and is formed into a large cavity with high brims, to assist in composing the great *acetabulum*; which shall be considered, after all the three bones that constitute the *os innominatum* are described.

The internal surface of the *os ilium* is concave in its broadest fore-part, where the internal iliac muscle has its origin, and some share of the *intestinum ilium* and *colon* is lodged.—From this large hollow a small sinuosity is continued obliquely forwards, at the inside of the anterior inferior spinal process, where part of the *psoas* and *iliacus* muscles, with the crural vessels and nerves, pass. The large concavity is bounded below by a sharp ridge, which runs from behind forwards; and, being continued with such another ridge of the *os pubis*, forms a line of partition between the *abdomen* and *pelvis*. Into this ridge the broad tendon of the *psoas parvus* is inserted.

All the internal surface of the *os ilium*, behind this ridge, is very unequal: for the upper part is flat, but spongy, where the *sacro-lumbalis* and *longissimus dorsi* rise.—Lower down, there is a transverse ridge, from which ligaments go out to the *os sacrum*.—Immediately below this ridge, the rough unequal cavities and prominences are placed, which are exactly adapted to those described on the side of the *os sacrum*.—In the same manner, the upper part of this rough surface is porous, for the firmer adhesion of the ligamentous cellular substance; while the lower part is more solid, and covered with a thin cartilaginous skin, for its immovable articulation with the *os sacrum*.—From all the circumference of this large unequal surface, ligaments are extended to the *os sacrum*, to secure more firmly the conjunction of these bones.

The passages of the medullary vessels are very conspicuous, both in the *dorsum* and *costa* of many *ossa ilium*; but in others they are inconsiderable.

The posterior and lower parts of these bones are thick; but they are generally exceeding thin and compact at their middle, where they are exposed to the actions of the *musculi glutæi* and *iliacus internus*, and to the pressure of the bowels contained in the belly.—The substance of the *ossa ilium* is mostly cellular, except a thin external table.

In a ripe child, the spine of the *os ilium* is cartilaginous, and is afterwards joined to the bone in form of an *epiphyse*.—The large lower end of this bone is not completely ossified.

OS ISCHIIUM (*a*), or *hip-bone*, is of a middle bulk between the two other parts of the *os innominatum*, is situated lowest of the three, and is of a very irregular figure.—Its extent might be marked by an horizontal line drawn near through the middle of the *acetabulum*; for the upper bulbous part of this bone forms some less than the lower half of that great cavity, and the small leg of it rises to much the same height on the other side of the great hole common to this bone and the *os pubis*.

From the upper thick part of the *os ischium*, a sharp process, called by some *spinous*, stands out backwards, from which chiefly the *musculus coccygæus* and *superior gemellus*, and part of the *levator ani*, rise; and the anterior or internal *sacro-sciatic* ligament is fixed to it.—Between the

upper

(*a*) Coxæ, coxendicis, paxis.

upper part of this ligament and the bones, it was formerly observed that the *pyriform* muscle, the posterior crural vessels, and the sciatic nerve, pass out of the *pelvis*.—Immediately below this process, a sinuosity is formed for the tendon of the *musculus obturator internus*.—In a recent subject, this part of the bone, which serves as a pulley on which the *obturator* muscle plays, is covered with a ligamentous cartilage, that, by two or three small ridges, points out the interstices of the fibres in the tendon of this muscle.—The outer surface of the bone at the root of this spinous process is made hollow by the *pyriformis* or *iliacus externus* muscle.

Below the sinuosity for the *obturator* muscle, is the great knob or *tuberosity*, covered with cartilage or tendon (*a*).—The upper part of the tuberosity gives rise to the inferior *gemellus* muscle.—To a ridge at the inside of this, the external or posterior *sacro-sciatic* ligament is so fixed, that between it, the internal ligament, and the sinuosity of the *os ischium*, a passage is left for the internal *obturator* muscle.—The upper thick smooth part of the *tuber*, called by some its *dorsum*, has two oblique impressions on it. The inner one gives origin to the long head of the *biceps flexor tibiae* and *seminervosus* muscles; and the *semimembranosus* rises from the exterior one, which reaches higher and nearer the *acetabulum* than the other.—The lower, thinner, more scabrous part of the knob which bends forwards, is also marked with two flat surfaces; whereof the internal is what we lean upon in sitting, and the external gives rise to the largest head of the *triceps adductor femoris*.—Between the external margin of the tuberosity and the great hole of the *os innominatum*, there is frequently an obtuse ridge extended down from the *acetabulum*, which gives origin to the *quadratus femoris*.—As the *tuber* advances forwards, it becomes smaller, and is rough, for the origin of the *musculus transversalis* and *erector penis*.—The small leg of it, which mounts upwards to join the *os pubis*, is rough and prominent at its edge, where the two lower heads of the *triceps* or *quadriceps adductor femoris* take their rise.

The upper and back part of the *os ischium* is broad and thick; but its lower and fore part is narrower and thinner.—Its substance is of the structure common to broad bones.

The *os ilium* and *pubis* of the same side are the only bones which are contiguous to the *os ischium*.

The

The part of the *os ischium* which forms the *acetabulum*, the spinous process, the great *tuber*, and the recurved leg, are all cartilaginous at birth. The *tuber*, with part of the leg or process above it, becomes an epiphysæ before this bone is fully formed.

The *OS PUBIS* (a), or *share-bone*, is the least of the three parts of the *os innominatum*, and is placed at the upper fore-part of it.—The thick largest part of this bone is employed in forming the *acetabulum*; from which becoming much smaller, it is stretched inwards to its fellow of the other side, where again it grows larger, and sends a small branch downwards to join the end of the small leg of the *os ischium*.—The upper fore-part of each *os pubis* is tuberosus and rough where the *musculus rectus* and *pyramidalis* are inserted.—From this a ridge is extended along the upper edge of the bone, in a continued line with such another of the *os ilium*, which divides the *abdomen* and *pelvis*. The ligament of *Fallopian* is fixed to the internal end of this ridge, and the smooth hollow below it is made by the *psoas* and *iliacus internus* muscles passing with the anterior crural vessels and nerves behind the ligament.—Some way below the former ridge another is extended from the tuberosus part of the *os pubis* downwards and outwards towards the *acetabulum*; between these two ridges the bone is hollow and smooth, for lodging the head of the *pectineus* muscle.—Immediately below, where the lower ridge is to take the turn downwards, a winding niche is made, which is comprehended in the great *foramen* of a skeleton, but is formed into a hole by a subtended ligament in the recent subject, for the passage of the posterior crural nerve, an artery, and a vein.—The internal end of the *os pubis* is rough and unequal, for the firmer adhesion of the thick ligamentous cartilage that connects it to its fellow of the other side.—The process which goes down from that to the *os ischium* is broad and rough before, where the *gracilis* and upper heads of the *triceps*, or rather *quadriceps*, *adductor femoris* have their origin.

The substance of the *os pubis* is the same as of other broad bones.

Only a part of the large end of this bone is ossified; and the whole leg is cartilaginous in a child born at the full time.

Betwixt the *os ischium* and *pubis* a very large irregular hole is left, which

X

from

(a) Εἶς, pectinis, penis, pudibundum, fenestratum.

from its resemblance to a door or shield, has been called *thyroides*. This hole is all, except the niche for the posterior crural nerve, filled up in a recent subject with a strong ligamentous membrane that adheres very firmly to its circumference. From this membrane chiefly the two *obturator* muscles, external and internal, take their rise.—The great design of this hole, besides rendering the bone lighter, is to allow a strong enough origin to the *obturator* muscles, and sufficient space for lodging their bellies, that there may be no danger of disturbing the functions of the contained *viscera* of the *pelvis* by the actions of the internal, nor of the external being bruised by the thigh-bone, especially by its lesser *trochanter*, in the motions of the thigh inwards: Both which inconveniencies must have happened, had the *ossa innominata* been complete here, and of sufficient thickness and strength to serve as the fixed point of these muscles.—The bowels sometimes make their way through the niche for the vessels, at the upper part of this *thyroid* hole; and this causes a *hernia* in this place (*a*).

In the external surface of the *ossa innominata*, near the outside of the great hole, a large deep cavity is formed by all the three bones conjunctly: for the *os pubis* constitutes about one fifth, the *os ilium* makes something less than two fifths, and the *os ischium* as much more than two fifths. The brims of this cavity are very high, and still much more enlarged by the ligamentous cartilage, with which they are tipped in a recent subject. From this form of the cavity it has been called *acetabulum*; and for a distinguishing character, the name of the bone that constitutes the largest share of it is added: therefore *acetabulum ossis ischii* (*b*) is the name this cavity commonly bears.—Round the base of the *supercilia* the bone is rough and unequal, where the capsular ligament of the articulation is fixed. The brims at the upper and back part of the *acetabulum* are much larger and higher than any where else; which is very necessary to prevent the head of the *femur* from slipping out of its cavity at this place, where the whole weight of the body bears upon it, and consequently would otherwise be constantly in danger of thrusting it out.—As these brims are extended downwards and forwards they become less; and at their internal lower part a breach is made in them; from the one side of which to the other a ligament is placed in the recent subject; under which a large
hole

(*a*) Memoires de l'Acad. de Chirurgie, tom. 1. p. 709, &c.

(*b*) Coxæ, coxendicis.

hole is left, which contains a fatty cellular substance and vessels. The reason of which appearance has afforded matter of debate. To me it seems evidently contrived for allowing a larger motion to the thigh inwards: for if the bony brims had been here continued, the neck of the thigh-bone must have struck upon them when the thighs were brought across each other; which, in a large strong motion this way, would have endangered the neck of the one bone, or brim of the other. Then the vessels which are distributed to the joint may safely enter at the sinuosity in the bottom of the breach; which being, however, larger than is necessary for that purpose, allows the large mucilaginous gland of the joint to escape below the ligament, when the head of the thigh-bone is in hazard of pressing too much upon it in the motions of the thigh outwards (*a*). Besides this difference in the height of the brims, the *acetabulum* is otherwise unequal; for the lower internal part of it is depressed below the cartilaginous surface of the upper part, and is not covered with cartilage: into the upper part of this particular depression, where it is deepest and of a femilunar form, the ligament of the thigh-bone, commonly, though improperly, called the *round* one, is inserted; while in its more superficial lower part the large mucilaginous gland of this joint is lodged. The largest share of this separate depression is formed in the *os ischium*.

From what has been said of the condition of the three bones composing this *acetabulum* in new-born children, it must be evident, that a considerable part of this cavity is cartilaginous in them.

The *ossa innominata* are joined at their back-part to each side of the *os sacrum* by a sort of suture, with a very thin intervening cartilage, which serves as so much glue to cement those bones together; and strong ligaments go from the circumference of this unequal surface to connect them more firmly. The *ossa innominata* are connected together at their fore-part by the ligamentous cartilage interposed between the two *ossa pubis*. These bones can therefore have no motion in a natural state, except what is common to the trunk of the body, or to the *os sacrum*. But it has been disputed, whether or not they loosen so much from each other and from the *os sacrum* in child-birth, by the flow of *mucus* to the *pelvis*, and by the throes of the labour, as that the *ossa pubis* recede from each other,

and thereby allow the passage between the bones to be enlarged.—Several observations (*a*) shew that this relaxation sometimes happens: but those who had frequently opportunities of dissecting the bodies of women who died immediately after being delivered of children, teach us to beware of regarding this as the common effect of child-birth; for they found such a relaxation in very few of the bodies which they examined (*b*).

Considering what great weight is supported, in our erect posture, by the articulation of the *ossa innominata* with the *os sacrum*; there is great reason to think, that, if the conglutinated surfaces of these bones were once separated, (without which the *ossa pubis* cannot shuffle on each other), the ligaments would be violently stretched, if not torn; from whence many disorders would arise (*c*).

Each *os innominatum* affords a socket (the *acetabulum*) for the thigh-bones to move in; and the trunk of the body rolls here so much on the heads of the thigh-bones, as to allow the most conspicuous motions of the *trunk*, which are commonly thought to be performed by the bones of the spine.—This articulation is to be more fully described after the *ossa femoris* are examined.

The *pelvis*, then, has a large open above where it is continued with the *abdomen*; is strongly fenced by bones on the sides, back, and fore-part; and appears with a wide opening below in the skeleton: but in the recent subject, a considerable part of the opening is filled by the *sacro-sciatic* ligaments, *pyriform*, *internal obturator*, *levatoris ani*, *gemini*, and *coccygæi* muscles, which support and protect the contained parts better than bones could have done; so that space is only left at the lowest part of it for the large excretories, the *vesica urinaria*, *intestinum rectum*, and in females the *uterus*, to discharge themselves.

The *THORAX* (*d*), or *chest*, which is the only part of the trunk of the body which we have not yet described, reaches from below the neck to the belly; and, by means of the bones that guard it, is formed into a large cavity:

(*a*) Bauhin. Theat. Anat. lib. 1. cap. 49.—Spigel. Anat. lib. 2. cap. 24.—Riolan. Anthropog. lib. 6. cap. 12.—Diemerbroeck, Anat. lib. 9. cap. 16.

(*b*) Hildan. Epist. Cent. obs. 46.—Dionis, Sixieme Demonst. des Os.—Morgagn. Advers. 3. animad. 15.

(*c*) Ludov. in Ephem. German. dec. 1. ann. 3. obs. 255.

(*d*) Pectus, cassum.

cavity: The figure of which is somewhat conoidal; but its upper smaller end is not finished, being left open for the passage of the wind-pipe, gullet, and large blood-vessels; and its lower part, or base, has no bones, and is shorter before than behind; so that, to carry on our comparison, it appears like an oblique section of the conoid. Besides which, we ought also to remark, that the lower part of this cavity is narrower than some way above (a); and that the middle of its back-part is considerably diminished by the bones standing forwards into it.

The bones which form the *thorax* are the twelve dorsal *vertebræ* behind, the ribs on the sides, and the *sternum* before.

The *vertebræ* have already been described as part of the spine; and therefore are now to be passed.

The RIBS, or *costæ* (b), (as if they were *custodes* or guards to those principal organs of the animal-machine, the heart and lungs), are the long crooked bones placed at the side of the chest, in an oblique direction downwards in respect of the back-bone.—Their number is generally twelve on each side; though frequently eleven or thirteen have been found (c). Sometimes the ribs are found preternaturally conjoined or divided (d).

The ribs are all concave internally; where they are also made smooth by the action of the contained parts, which, on this account, are in no danger of being hurt by them; and they are convex externally, that they might resist that part of the pressure of the atmosphere, which is not balanced by the air within the lungs during *inspiration*.—The ends of the ribs next the *vertebræ* are rounder than they are after these bones have advanced forwards, when they become flatter and broader, and have an upper and lower edge; each of which is made rough by the action of the *intercostal* muscles inserted into them. These muscles, being all of nearly equal force, and equally stretched in the interstices of the ribs, prevent the broken ends of these bones in a fracture from being removed far out of their natural place, to interrupt the motion of the vital organs. The upper edge of the ribs is more obtuse and rounder than the lower, which

(a) Albin. de Ossib. § 169.

(b) πλευραι, περιστενα, σπασται.

(c) Riolan. Comment. de Ossibus, cap. 19.—Morebetti, cap. 9. Cowper's Explicat. of tab. 93 & 94.—Morgagn. Advers. Anat.

(d) Sue Trad. d'Osteolog. p. 141.

which is depressed on its internal side by a long *fossa* for lodging the intercostal vessels and nerves; on each side of which there is a ridge, to which the intercostal muscles are fixed. The *fossa* is not observable, however, at either end of the ribs: for at the posterior or root the vessels have not yet reached the ribs; and at the fore-end they are split away into branches, to serve the parts between the ribs: which plainly teaches surgeons one reason of the greater safety of performing the operation of the *empyema* towards the sides of the *thorax*, than either near the back or the breast.

At the posterior end (*a*) of each *rib* a little head is formed, which is divided by a middle ridge into two plain or hollow surfaces; the lowest of which is the broadest and deepest in most of them. The two plains are joined to the bodies of two different *vertebræ*, and the ridge forces itself into the intervening cartilage.—A little way from this head, we find, on the external surface, a small cavity, where mucilaginous glands are lodged; and round the head the bone appears spongy, where the capsular ligament of the articulation is fixed.—Immediately beyond this a flattened tubercle rises, with a small cavity at, and roughness about its root, for the articulation of the rib with the transverse process of the lowest of the two *vertebræ*, with the bodies of which the head of the rib is joined.—Advancing farther on this external surface, we observe in most of the ribs another smaller tubercle; into which ligaments which connect the ribs to each other and to the transverse processes of the *vertebræ*, and portions of the *longissimus dorsi*, are inserted.—Beyond this the ribs are made flat by the *sacro-lumbalis* muscle, which is inserted into the part of this flat surface farthest from the spine, where each rib makes a considerable curve, called by some its *angle*.—Then the rib begins to turn broad, and continues so to its anterior end (*b*), which is hollow and spongy for the reception of, and firm coalition with, the cartilage that runs thence to be inserted into the *sternum*, or to be joined with some other cartilage.—In adults, generally the cavity at this end of the ribs is smooth and polished on its surface; by which the articulation of the cartilage with it has the appearance of being designed for motion, but it has none.

The substance of the ribs is spongy, cellular, and only covered with a
very

(*a*) Κορυφή, remulus.

(*b*) Πλάτη, palmula.

very thin external lamellated surface, which increases in thickness and strength as it approaches the *vertebræ*.

To the fore-end of each rib a long broad and strong cartilage is fixed, and reaches thence to the *sternum*, or is joined to the cartilage of the next rib. This course, however, is not in a straight line with the rib; for generally the cartilages make a considerable curve, the concave part of which is upwards: therefore at their insertion into the *sternum*, they make an obtuse angle above, and an acute one below.—These cartilages are of such a length as never to allow the ribs to come to a right angle with the spine; but they keep them situated so obliquely, as to make an angle very considerably obtuse above, till a force exceeding the elasticity of the cartilages is applied. These cartilages, as all others, are firmer and harder internally than they are on their external surface; and sometimes, in old people, all their middle substance becomes bony, while a thin cartilaginous *lamella* appears externally (a). The ossification, however, begins frequently at the external surface.—The greatest alternate motions of the cartilages being made at their great curvature, that part remains frequently cartilaginous, after all the rest is ossified (b).

The ribs then are articulated at each end, of which the one behind is doubly joined to the *vertebræ*; for the head is received into the cavities of two bodies of the *vertebræ*, and the larger tubercle is received into the depression in the transverse process of the lower *vertebra*.—When one examines the double articulation, he must immediately see, that no other motion can here be allowed than upwards and downwards; since the transverse process hinders the rib to be thrust back; the resistance on the other side of the *sternum* prevents the ribs coming forward; and each of the two joints, with the other parts attached, oppose its turning round. But then it is likewise as evident, that even the motion upwards and downwards can be but small, in any one rib, at the articulation itself. But as the ribs advance forwards, the distance from their centre of motion increasing, the motion must be larger: and it would be very conspicuous at their anterior ends, were they not resisted there by the cartilages; which yield so little, that the principal motion is performed by the middle part of the ribs, which turns outwards and upwards, and occasions the twist

(a) Vesal. lib. 2. cap. 19.

(b) Havers, Osteolog. Nov. disc. 5. p. 289.

twist remarkable in the long ribs at the place near their fore-end where they are most resisted (*a*).

Hitherto I have laid down the structure and connection which most of the ribs enjoy, as belonging to all of them; but must now consider the specialities wherein any of them differ from the general description given, or from each other.

In viewing the ribs from above downwards, their figure is still straighter; the uppermost being the most crooked of any.—Their obliquity, in respect of the spine, increases as they descend: so that though their distances from each other is very little different at their back-part, yet at their fore-ends the distances between the lower ones must increase.—In consequence too of this increased obliquity of the lower ribs, each of their cartilages makes a greater curve in its progress from the rib towards the *sternum*; and the tubercles that are articulated to the transverse processes of the *vertebræ*, have their smooth surfaces gradually facing more upwards.—The ribs becoming thus more oblique, while the *sternum* advances forwards in its descent, makes the distance between the *sternum* and the anterior end of the lower ribs greater than between the *sternum* and the ribs above; consequently the cartilages of those ribs that are joined to the breast-bone are longer in the lower than in the higher ones.—These cartilages are placed nearer to each other as the ribs descend; which occasions the curvature of the cartilages to be greater.

The length of the ribs increases from the first and uppermost rib as far down as the seventh; and from that to the twelfth as gradually diminishes.—The superior of the two plain, or rather hollow surfaces, by which the ribs are articulated to the bodies of the *vertebræ*, gradually increases from the first to the fourth rib, and is diminished after that in each lower rib.—The distance of their angles from the heads always increases as they descend to the ninth, because of the greater breadth of the *sacro-lumbalis* muscle (*b*).

The ribs are commonly divided into *true* and *false*.

The *true* (*c*) *costæ* are the seven upper ones of each side, whose cartilages

(*a*) Winflow, *Memoires de l'Acad. des Sciences*, 1720.

(*b*) Winflow, *Exposition Anatomique des Os secs*, § 643.

(*c*) *ῥησκι*, *germanæ*, *legitimæ*.

ges are all gradually longer as the ribs descend, and are joined to the breast-bone: so that, being pressed constantly between two bones, they are flatted at both ends; and are thicker, harder, and more liable to ossify, than the other cartilages that are not subject to so much pressure. These ribs include the heart and lungs; and therefore are the proper or true *custodes* of life.

The five inferior ribs of each side are the *false* or BASTARD (*a*), whose cartilages do not reach to the *sternum*; and therefore wanting the resistance at their fore-part, they are there pointed; and, on this account, having less pressure, their substance is softer.—The cartilages of these *false ribs* are shorter as the ribs descend.—To all these five ribs the circular edge of the *diaphragm* is connected; and its fibres, instead of being stretched immediately transversely, and so running perpendicular to the ribs, are pressed so as to be often, especially in expiration, parallel to the plane in which the ribs lie: Nay, one may judge by the attachments which these fibres have so frequently to the sides of the *thorax*, a considerable way above where their extremities are inserted into the ribs, and by the situation of the *viscera*, always to be observed in a dead subject laid supine, that there is constantly a large concavity formed on each side by the *diaphragm* within these bastard ribs, in which the stomach, liver, spleen, &c. are contained; which being only reckoned among the *viscera naturalia*, have occasioned the name of *bastard custodes* to these bones.

Hence in simple fractures of the false ribs, without fever, the stomach ought to be kept moderately filled with food, lest the pendulous ribs falling inwards, should thereby increase the pain, cough, &c. (*b*).—Hence likewise we may learn how to judge better of the seat of several diseases, and to do the operation of the *empyema*, and some others, with more safety than we can do if we follow the common directions.

The eight upper ribs were formerly (*c*) classed into pairs, with particular names to each two, to wit, the *crooked*, the *solid*, the *pectoral*, the *twisted*: But these names are of so little use, that they are now generally neglected.

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The

(*a*) Μαλθακαί, χονδρότεροι, ακανθαί, κλίστε, πταί, adulterinæ, spuræ, illegitimæ.

(*b*) Hippocrat. de Articulo, § 51.—Parè, lib. 15. cap. 11.

(*c*) Laurent. Hist. Anat. lib. 2. cap. 29.—Paaw, de Ossibus, part 3. cap. 2.

The *first* rib of each side is so situated, that the flat sides are above and below, while one edge is placed inwards, and the other outwards, or nearly so; therefore sufficient space is left above it for the subclavian vessels and muscle; and the broad concave surface is opposed to the lungs: But then, in consequence of this situation, the channel for the intercostal vessels is not to be found, and the edges are differently formed from all the other, except the second; the lower one being rounded, and the other sharp.—The head of this rib is not divided into two plain surfaces by a middle ridge, because it is only articulated with the first *vertebra* of the *thorax*.—Its cartilage is ossified in adults, and is united to the *sternum* at right angles.—Frequently this first rib has a ridge rising near the middle of its posterior edge, where one of the heads of the *scalenus* muscle rises.—Farther forward it is flattened, or sometimes depressed, by the clavicle.

The fifth, sixth, and seventh, or rather the sixth, seventh, eighth, and sometimes the fifth, sixth, seventh, eighth, ninth ribs, have their cartilages at least contiguous; and frequently they are joined to each other by cross cartilages; and most commonly the cartilages of the eighth, ninth, tenth, are connected to the former and to each other by firm ligaments.

The *eleventh*, and sometimes the *tenth* rib, has no tubercle for its articulation with the transverse process of the *vertebra*, to which it is only loosely fixed by ligaments.—The *fossa* in its lower edge is not so deep as in the upper ribs, because the vessels run more towards the interstice between the ribs.—Its fore-end is smaller than its body, and its short small cartilage is but loosely connected to the cartilage of the rib above.

The *twelfth* rib is the shortest and straightest.—Its head is only articulated with the last *vertebra* of the *thorax*; therefore is not divided into two surfaces.—This rib is not joined to the transverse process of the *vertebra*, and therefore has no tubercle, being often pulled necessarily inwards by the diaphragm, which an articulation with the transverse process would not have allowed.—The *fossa* is not found at its under edge, because the vessels run below it.—The fore-part of this rib is smaller than its middle, and has only a very small pointed cartilage fixed to it. To its whole internal side the diaphragm is connected.

The motions and uses of the ribs shall be more particularly treated of after the description of the *sternum*.

The heads and tubercles of the ribs of a new-born child have cartilages on them; part of which becomes afterwards thin epiphyses.—The bodies of the ribs encroach gradually after birth upon the cartilages; so that the latter are proportionally shorter, when compared to the ribs, in adults than in children.

Here I cannot help remarking the wise providence of our Creator, in preserving us from perishing as soon as we come into the world. The end of the bones of the limbs remain in a cartilaginous state after birth, and are many years before they are entirely united to the main body of their several bones: whereas the condyles of the occipital bone, and of the lower jaw, are true original processes, and ossified before birth; and the heads and tubercles of the ribs are nearly in the same condition; and therefore the weight of the large head is firmly supported; the actions of sucking, swallowing, respiration, &c. which are indispensably necessary for us as soon as we come into the world, are performed without danger of separating the parts of the bones that are most pressed on in these motions: Whereas, had these processes of the head, jaw, and ribs, been epiphyses at birth, children must have been exposed to danger of dying by such a separation; the immediate consequences of which would be, the compression of the beginning of the *spinal* marrow, or want of food, or a stop put to respiration.

The STERNUM (*a*), or *breast-bone*, is the broad flat bone, or pile of bones, at the fore-part of the *thorax*.—The number of bones which this should be divided into, has occasioned debates among anatomists, who have considered it in subjects of different ages.—In adults of a middle age, it is composed of three bones, which easily separate after the cartilages connecting them are destroyed. Frequently the two lower bones are found intimately united; and very often, in old people, the *sternum* is a continued bony substance from one end to the other; though we still observe two, sometimes three, transverse lines on its surface; which are marks of the former divisions.

When we consider the *sternum* as one bone, we find it broadest and

Y 2

thickest

(a) Στήθος, os pectoris, ensiforme, scutum cordis.

thickest above, and becoming smaller as it descends. The internal surface of this bone is somewhat hollowed for enlarging the *thorax*: but the convexity on the external surface is not so conspicuous, because the sides are pressed outwards by the true ribs; the round heads of whose cartilages are received into seven smooth pits, formed in each side of the *sternum*, and are kept firm there by strong ligaments, which on the external surface have a particular radiated texture (*a*).—Frequently the cartilaginous fibres thrust themselves into the bony substance of the *sternum*, and are joined by a sort of future.—The pits at the upper part of the *sternum* are at the greatest distance one from another, and, as they descend, are nearer; so that the two lowest are contiguous.

The substance of the breast-bone is cellular, with a very thin external plate, especially on its internal surface, where we may frequently observe a cartilaginous crust spread over it (*b*). On both surfaces, however, a strong ligamentous membrane is closely braced; and the cells of this bone are so small, that a considerable quantity of osseous fibres must be employed in the composition of it: Whence, with the defence which the muscles give it, and the moveable support it has from the cartilages, it is sufficiently secured from being broken; for it is strong by its quantity of bone, its parts are kept together by ligaments, and it yields enough to elude considerably the violence offered (*c*).

So far may be said of this bone in general; but the three bones, of which, according to the common account, it is composed in adults, are each to be examined.

The *first*, all agree, is somewhat of the figure of a heart, as it is commonly painted; only it does not terminate in a sharp point,—This is the uppermost thickest part of the *sternum*.

The upper middle part of this first bone, where it is thickest, is hollowed, to make place for the *trachea arteria*; though this cavity (*d*) is principally formed by the bone being raised on each side of it, partly by the clavicles thrusting it inwards, and partly by the *sterno-mastoidei* muscles pulling it upwards.—On the outside of each tubercle, there is

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(*a*) Ruyfch. Catalog. Rar. fig. 9.

(*b*) Jac. Sylv. in Galen. de Ossibus, cap. 12.

(*b*) Senac. in Memoires de l'Acad. des Sciences, 1724.

(*c*) *Σταγν*, jugulum, furcula superior,

an oblong cavity, that, in viewing it transversely from before backwards, appears a little convex : Into these *glenæ* the ends of the clavicles are received.—Immediately below these, the sides of this bone begin to turn thinner ; and in each a superficial cavity or a rough surface is to be seen, where the first ribs are received or joined to the *sternum*.—In the side of the under-end of this first bone, the half of the pit for the second rib on each side is formed.—The upper part of the surface behind is covered with a strong ligament, which secures the clavicles ; and is afterwards to be more particularly taken notice of.

The second or middle division of this bone, is much longer, narrower, and thinner, than the first ; but, excepting that it is a little narrower above than below, it is nearly equal all over in its dimensions of breadth or thickness.—In the sides of it are complete pits for the third, fourth, fifth, and sixth ribs, and an half of the pits for the second and seventh ; the lines, which are marks of the former division of the bone, being extended from the middle of the pits of one side to the middle of the corresponding pits of the other side.—Near its middle an unossified part of the bone is sometimes found, which, freed of the ligamentous membrane or cartilage that fills it, is described as a hole ; and in this place, for the most part, we may observe a transverse line, which has made authors divide this bone into two.—When the cartilage between this and the first bone is not ossified, a manifest motion of this upon the first may be observed in respiration or in raising the *sternum*, by pulling the ribs upwards or distending the lungs with air in a recent subject.

The third bone is much less than the other two, and has only one half of the pit for the seventh rib formed in it ; wherefore it might be reckoned only an *appendix* of the *sternum*.—In young subjects, it is always cartilaginous ; and is better known by the name of *cartilago xiphoides*, or *ensiformis* (a), than any other : though the ancients often called the whole *sternum*, *ensiforme* ; comparing the two first bones to the handle, and this *appendix* to the blade, of a sword.—This third bone is seldom of the same figure, magnitude, or situation, in any two subjects. For sometimes it is a plain triangular bone, with one of the angles below, and perpendicular

to.

(a) Clypealis, gladialis, mucronata, malum granatum, scutum stomachi, epiglottalis, cultralis, medium furculæ inferioris, scutiformis, ensiculata.

to the middle of the upper side, by which it is connected to the second bone.—In other people, the point is turned to one side, or obliquely forwards or backwards.—Frequently it is all nearly of an equal breadth; and in several subjects it is bifurcated, whence some writers give it the name of *furcella* or *furcula inferior*; or else it is unossified, in the middle.—In the greatest number of adults it is ossified, and tipped with a cartilage; in some, one half of it is cartilaginous; and in others, it is all in a cartilaginous state.—Generally several oblique ligaments, fixed at one end to the cartilages of the ribs, and by the other to the outer surface of the *xiphoid* bone, connect it firmly to those cartilages (*a*).

So many different ways this small bone may be formed, without any inconvenience: But then some of these positions may be so directed, as to bring on a great train of ill consequences; particularly, when the lower end is ossified, and is too much turned outwards or inwards (*b*), or when the conjunction of this *appendix* with the second bone is too weak (*c*).

The *sternum* is joined by cartilages to the seven upper ribs, unless when the first coalesces with it in an intimate union of substance; and its unequal cavity on each side of its upper end is fitted for the ends of the clavicles.

The *sternum* most frequently has four round small bones, surrounded with cartilage, in children born at the full time; the uppermost of these, which is the first bone, being the largest.—Two or three other very small bony points are likewise to be seen in several children.—The number of bones increases for some years; and then diminishes, but uncertainly, till they are at last united into those above described of an adult.

The uses of this bone are, to afford origin and insertion to several muscles; to sustain the *mediastinum*; to defend the vital organs, the heart and lungs, at the fore-part; and, lastly, by serving as a moveable *fulcrum* of the ribs, to assist considerably in respiration: Which action, so far as it depends on the motion of the bones, we are now at liberty to explain.

When

(*a*) Weitbrecht, *Syndesmolog.* p. 121.

(*b*) Rolfini. *Dissert. Anat.* lib. 2. cap. 41.—Paaw, de *Ossib.* parte 1. cap. 3. & parte 3. cap. 3.—Codronchi de *Prolapsu Cartilagin.* Mucronat.

(*c*) Paaw, *ibid.*—Borrigh. *Act. Hafn.* vol. 5. ob. 79.—Bonet. *Sepulchret. Anat.* tom. 2. lib. 3. § 5. *append. ad obs.* 8.; et *ibid.* §. 7. *obs.* 19.

When the ribs that are connected by their cartilages to the *sternum*, or to the cartilages of the true ribs, are acted upon by the intercostal muscles, they must all be pulled from the oblique position which their cartilages kept them in, nearer to right angles with the *vertebræ* and *sternum*, because the first or uppermost rib is by much the most fixed of any; and the cartilages making a great resistance to raising the anterior ends of the ribs, their large arched middle parts turn outwards as well as upwards.—The *sternum*, pressed strongly on both sides by the cartilages of the ribs, is pushed forwards; and that at its several parts, in proportion to the length and motion of its supporters, the ribs; that is, most at its lower end.—The *sternum* and the cartilages, thus raised forwards, must draw the *diaphragm* connected to them; consequently so far stretch it, and bring it nearer to a plane.—The power that raises this bone and the cartilages, fixes them sufficiently to make them resist the action of the *diaphragm*, whose fibres contract at the same time, and thrust the *viscera* of the *abdomen* downwards.—The arched part of the ribs being thus moved outwards, their anterior ends and the *sternum* being advanced forwards, and the *diaphragm* being brought nearer to a plain surface, instead of being greatly convex on each side within each cavity of the *thorax*, it is evident how considerably the cavity, of which the nine or ten upper ribs are the sides, must be widened, and made deeper and longer.—While this is doing in the upper ribs, the lower ones, whose cartilages are not joined to the *sternum* or to other cartilages, move very differently, though they conspire to the same intention, the enlargement of the *thorax*: For having no fixed point to which their anterior ends are fastened, and the *diaphragm* being inserted into them at the place where it runs pretty straight upwards from its origin at the *vertebræ*, these ribs are drawn downwards by this strong muscle, and by the muscles of the *abdomen*, which, at this time, are resisting the stretching force of the bowels; while the intercostal muscles are pulling them in the contrary direction, to wit, upwards: The effect, therefore, of either of these powers, which are antagonists to each other, is very little, as to moving the ribs either up or down; but the muscles of the *abdomen*, pushed at this time outwards by the *viscera*, carry these ribs along with them.—Thus the *thorax* is not only not allowed to be shortened, but is really widened at its lower part,

part, to assist in making sufficient space for the due distension of the lungs.

As soon as the action of these several muscles ceases, the elastic cartilages, extending themselves to their natural situation, depress the upper ribs, and the *sternum* subsides; the diaphragm is thrust up by the *viscera abdominalia*, and the oblique and transverse muscles of the belly serve to draw the inferior ribs inwards at the same time.—By these causes, the cavity of the breast is diminished in all its dimensions.

Though the motions above described of the ribs and *sternum*, especially of the latter bone, are so small in the mild respiration of a healthy person, that we can scarce observe them; yet they are manifest whenever we designedly increase our respiration, or are obliged to do it after exercise, and in several diseases.

OF THE SUPERIOR EXTREMITIES.

AUTHORS are much divided in their opinions about the number of bones which each *superior extremity* (a) should be said to consist of; some describing the *clavicle* and *scapula* as part of it, others classing these two bones with those of the *thorax*: But since most quadrupeds have no *clavicles*, and the human *thorax* can perform its functions right when the *scapula* is taken away (b), whereas it is impossible for us to have the right use of our arms without these bones; I must think that they belong to the *superior extremities*; and therefore shall divide each of them into the *shoulder*, *arm*, *fore-arm*, and *hand*.

The SHOULDER consists of the *clavicle* and *scapula*.

CLAVICULA, or *collar-bone* (c), is the long crooked bone, in figure like an *Italic s*, placed almost horizontally between the upper lateral part of the *sternum*, and what is commonly called the top of the shoulder, which, as a *clavis* or beam, it bears off from the trunk of the body.

The *clavicle*, as well as other long round bones, is larger at its two ends,

(a) *Κωλα, γυα, εκρυαδεις*, enata, adnata, explanata membra, artus.

(b) Philosoph. Transact. numb. 449. §. 5.

(c) Os jugulare, jugulum, furcula, ligula, clavis, humerus quibusdam.

ends, than in the middle. The end next to the *sternum* (*a*) is triangular: The angle behind is considerably produced, to form a sharp ridge, to which the transverse ligament extended from one clavicle to the other is fixed (*b*).—The side opposite to this is somewhat rounded.—The middle of this protuberant end is as irregularly hollowed, as the cavity in the *sternum* for receiving it is raised: but in a recent subject, the irregular concavities of both are supplied by a moveable cartilage, which is not only much more closely connected every where by ligaments to the circumference of the articulation, than those of the lower jaw are; but it grows to the two bones at both its internal and external end; its substance at the internal end being soft, but very strong, and resembling the intervertebral cartilages (*c*).

From this internal end, the *clavicle*, for about two fifths of its length, is bended obliquely forwards and downwards. On the upper and fore part of this curvature a small ridge is seen, with a plain rough surface before it; whence the *musculus sterno-hyoideus* and *sterno-mastoideus* have in part their origin.—Near the lower angle a small plain surface is often to be remarked, where the first rib and this bone are contiguous (*d*), and are connected by a firm ligament (*e*).—From this a rough plain surface is extended outwards, where the pectoral muscle has part of its origin.—Behind, the bone is made flat and rough by the insertion of the larger share of the subclavian muscle.—After the clavicle begins to be bended backwards, it is round, but soon after becomes broad and thin; which shape it retains to its external end.—Along the external concavity, a rough sinuosity runs, from which some part of the deltoid muscle takes its rise:—Opposite to this, on the convex edge, a scabrous ridge gives insertion to a share of the *cucullaris* muscle. The upper surface of the clavicle here is flat; but the lower is hollow, for lodging the beginning of the *musculus subclavius*; and towards its back part a tubercle rises, to which, and a roughness near it, the strong short thick ligament connecting this bone to the *coracoid* process of the *scapula* is fixed.

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The

(*a*) Παρασπαιγίς.

(*b*) Riolan. Encheirid. Anat. lib. 6. cap. 13.—Winslow, Expos. Anat. des os frais, § 248.—Weitbrecht, Act. Petropolit. tom. iv. p. 255. et Syndesmolog. sect. 2. I. §. 3.

(*c*) Weitbrecht, Syndesmolog. sect. 2. I. § 6. (*d*) Dionis, Sixieme Demonst. des Os.

(*e*) Weitbrecht, Syndesmolog. sect. 2. I. § 7.

The external end (a) of this bone is horizontally oblong, smooth, sloping at the posterior side, and tipped in a recent subject with a cartilage, for its articulation with the *acromion scapulæ*.—Round this the bone is spongy, for the firmer connection of the ligaments.

The medullary arteries, having their direction obliquely outwards, enter the clavicles by one or more small passages in the middle of their back-part.

The substance of this bone is the same as of the other round long bones.

The triangular unequal interior end of each *clavicle*, has the cartilage above described interposed betwixt it and the irregular cavity of the *sternum*.—The ligaments, which surround this articulation to secure it, are so short and strong, that little motion can be allowed any way; and the strong ligament that is stretched across the upper *furcula* of the *sternum*, from the posterior prominent angle of the one clavicle, to the same place of the other clavicle, serves to keep each of these bones more firmly in their place.—By the assistance, however, of the moveable intervening cartilage, the clavicle can, at this joint, be raised or depressed, and moved backwards and forwards so much, as that the external end, which is at a great distance from that axis, enjoys very conspicuous motions.—The articulation of the exterior end of the clavicle shall be considered after the description of the *scapula*.

The clavicles of infants are not deficient in any of their parts: nor have they any epiphyses at their extremities joined afterwards to their bodies, as most other such long bones have; which preserves them from being bended too much, and from the danger of any unossified parts being separated by the force which pulls the arms forwards.

The uses of the clavicles are, to keep the *scapulæ*, and consequently all the *superior extremities*, from falling in and forward upon the *thorax*; by which, as in most quadrupeds, the motions of the arms would be much confined, and the breast made too narrow.—The clavicles likewise afford origin to several muscles, and a defence to large vessels.

From the situation, figure, and use of the clavicles, it is evident, that they are much exposed to fractures; that their broken parts must generally

rally go by each other, and that they are difficultly kept in their place afterwards.

SCAPULA, or *shoulder-blade* (a), is the triangular bone situated on the outside of the ribs, with its longest side, called its *base*, towards the spinal processes of the *vertebræ*; and with the angle at the upper part of this side about three inches, and the lower angle at a greater distance, from these processes.—The back-part of the *scapula* has nothing but the thin ends of the *serratus anticus major* and *subscapularis* muscles between it and the ribs: But as this bone advances forwards, its distance from the ribs increases.—The upper or shortest side, called the *superior costa* of the *scapula*, is nearly horizontal, and parallel with the second rib.—The lower side, which is named the *inferior costa*, is extended obliquely from the third to the eighth rib.—The situation of this bone here described, is when people are sitting or standing in a state of inactivity, and allowing the members to remain in the most natural easy posture.—The inferior angle of the *scapula* is very acute; the upper one is near to a right angle; and what is called the *anterior* does not deserve the name, for the two sides do not meet to form an angle.—The body of this bone is concave towards the ribs, and convex behind, where it has the name of *dorsum* (b). Three processes are generally reckoned to proceed from the *scapula*.—The first is the large spine that rises from its convex surface behind, and divides it unequally.—The second process stands out from the fore-part of the upper side; and from its imaginary resemblance to a crow's beak, is named *coracoides* (c).—The third process is the whole thick bulbous fore-part of the bone.

After thus naming the several constituent parts of the *scapula*, the particular description will be more easily understood.

The *base*, which is tipped with cartilage in a young subject, is not all straight. For above the spine, it runs obliquely forwards to the superior angle, that here it might not be too protuberant backwards, and so bruise the muscles and teguments: Into the oblique space the *musculus patientiæ* is inserted.—At the root of the spine, on the back-part of the base, a

Z 2

triangular

(a) ὤμοπλατος, ἐπινωτιον, latitudo humeri, scoptulum vel scutulum opertum, spatula, ala, humerus, clypeus, scutum thoracis.

(b) Χειλυνιον.

(c) Anchoroides, sigmoides, digitalis, ancistroides.

triangular plain surface is formed by the pressure of the lower fibres of the *trapezius*.—Below this, the edge of the *scapula* is scabrous and rough, for the insertion of the *serratus major anticus* and *rhomboid* muscles.

The back-part of the inferior angle is made smooth by the *latissimus dorsi* passing over it. This muscle also alters the direction of the *inferior costa* some way forwards from this angle; and so far it is flatted behind by the origin of the *teres major*.—As the *inferior costa* advances forward, it is of considerable thickness, is slightly hollowed and made smooth behind by the *teres minor*, while it has a *fossa* formed into it below by part of the *subscapularis*; and between the two, a ridge with a small depression appears, where the *longus extensor cubiti* has its origin.

The *superior costa* is very thin; and near its fore-part there is a semilunar niche, from one end of which to the other a ligament is stretched; and sometimes the bone is continued, to form one, or sometimes two holes for the passage of the scapular blood-vessels and nerves.—Immediately behind this *semilunar* cavity the *coraco-hyoid* muscle has its rise.—From the niche to the termination of the *fossa* for the *teres minor*, the *scapula* is narrower than any where else, and supports the third process. This part has the name of *cervix*.

The whole *dorsum* of the *scapula* is always said to be convex; but by reason of the raised edges that surround it, it is divided into two cavities by the spine, which is stretched from behind forwards, much nearer to the superior than to the *inferior costa*.—The cavity above the spine is really concave where the *supra-spinatus* muscle is lodged; while the surface of this bone below the spine, on which the *infra-spinatus* muscle is placed, is convex, except a *fossa* that runs at the side of the *inferior costa*.

The internal or anterior surface of this bone is hollow, except in the part above the spine, which is convex.—The *subscapularis* muscle is extended over this surface, where it forms several ridges and intermediate depressions, commonly mistaken for prints of the ribs; they point out the interstices of the bundles of fibres of which the *subscapularis* muscle is composed (a).

The spine (b) rises small at the base of the *scapula*, and becomes higher and

(a) Winflow, in Memoires de l'Acad. des Sciences, 1722.

(b) Γαχίς, υπερχη ωμοπλάτων, eminentia scapularum.

and broader as it advances forwards.—On the sides, it is unequally hollowed and crooked by the actions of the adjacent muscles.—Its ridge (*a*) is divided into two rough flat surfaces: into the upper one, the *trapezius* muscle is inserted; and the lower one has part of the *deltoid* fixed to it.—The end of the spine, called *acromion* (*b*), or top of the shoulder, is broad and flat, and is sometimes only joined to the spine by a cartilage (*c*).—The anterior edge of the *acromion* is flat, smooth, and covered with a cartilage, for its articulation with the external end of the clavicle; and it is hollowed below, to allow a passage to the *infra* and *supra spinati* muscles, and free motion to the *os humeri*.

The *coracoid* (*d*) process is crooked, with its point inclining forwards; so that a hollow is left at the lower side of its root, for the passage of the *infra-scapularis* muscle.—The end of this process is marked with three plain surfaces. Into the internal, the *ferratus minor anticus* is inserted; from the external, one head of the *biceps flexor cubiti* rises; and from the lower one, the *coracobrachialis* has its origin.—At the upper part of the root of this process, immediately before the *femilunar* cavity, a smooth tubercle appears, where a ligament from the *clavicle* is fixed. From all the external side of this coracoid *apophyse*, a broad ligament goes out, which becomes narrower where it is fixed to the *acromion*.—The sharp pain, violent inflammation, and tedious cure of contusions in this part, are probably owing to these tendons and ligaments being hurt.

From the *cervix scapulæ* the third process is produced. The fore-part of this is formed into a *glenoid* cavity (*e*), which is of the shape of the longitudinal section of an egg, being broad below and narrow above.—Between the brims of this hollow and the fore-part of the root of the spine, a large sinuosity is left for the transmission of the *supra* and *infra spinati* muscles; and on the upper part of these brims we may remark a smooth surface, where the second head of the *biceps flexor cubiti* has its origin.—The root of the *supercilia* is rough all round, for the firmer adhesion of the capsular ligament of the articulation, and of the cartilage which is placed

(*a*) Pterigium, crista.

(*b*) Επωμης αγκυροειδης, κορακοειδης, κατακλις, acromii os, summus armus, rostrum porcinum, processus digitalis.

(*c*) Sue Trad. d'Osteol. p. 160.

(*d*) Αγκυροειδης, σιγμοειδης, rostriformis.

(*e*) Ωμοκοτυλις.

placed on these brims, where it is thick, but becomes very thin as it is continued towards the middle of the cavity, which it lines all over.

The medullary vessels enter the *scapula* near the base of the spine.

The substance of the *scapula*, as in all other broad flat bones, is cellular, but of an unequal thickness; for the neck and third process are thick and strong. The inferior *costa*, spine, and coracoid process, are of a middle thickness; and the body is so pressed by the muscles, as to become thin and diaphanous.

The *scapula* and clavicle are joined by plain surfaces, tipped with cartilage (*a*): by which neither bone is allowed any considerable motion, being tightly tied down by the common capsular ligament, and by a very strong one which proceeds from the coracoid process; but divides into two before it is fixed into the *clavicle*, with such a direction, as either can allow this bone to have a small rotation, in which its posterior edge turns more backwards, while the anterior one rises farther forwards; or it can yield to the fore-part of the *scapula* moving downwards, while the back-part of it is drawn upwards: in both which cases, the oblong smooth articulated surfaces of the *clavicle* and *scapula* are not in the same plane, but stand a little transversely, or across each other, and thereby preserve this joint from luxations, to which it would be subject, if either of the bones was to move on the other perpendicularly up and down, without any rotation.—Sometimes a moveable ligamentous cartilage is found in this joint; otherwhiles such a cartilage is only interposed at the anterior half of it; and in some old subjects I have found a sesamoid bone here (*b*).—The *scapula* is connected to the head, *os hyoides*, *vertebræ*, ribs, and arm-bone, by muscles, that have one end fastened to these bones, and the other to the *scapula*, which can move it upwards, downwards, backwards, or forwards; by the quick succession of these motions, its whole body is carried in a circle: but being also often moved as upon an axis perpendicular to its plane, its circumference turns in a circle, whose centre this axis is (*c*). Whichever of these motions it performs, it always carries the outer end of the clavicle and the arm along with it.—The *glenoid* cavity

(*a*) Acromion, *κατακλις*, *clausuræ*.

(*b*) Jac. Sylv. *Isagog. Anat. lib. 1. cap. 2.*

(*c*) See Winslow, *Memoires de l'Acad. des Sciences*, 1726.

vity of this bone receives the *os humeri*, which plays in it as a ball in a socket, as will be explained more hereafter.

The use of the *scapula* is to serve as a *fulcrum* to the arm; and, by altering its position on different occasions, to allow always the head of the *os humeri* a right situated socket to move in; and thereby to assist and to enlarge greatly the motions of the *superior extremity*, and to afford the muscles which rise from it more advantageous actions, by altering their directions to the bone which they are to move.—This bone also serves to defend the back-part of the *thorax*; and is often employed to sustain weights, or to resist forces, too great for the arm to bear.

The base, *acromion*, coracoid process, and head of the *scapula*, are all in a cartilaginous state at birth; and the three first are joined as *epiphyses*; while the head, with the *glenoid* cavity, is not formed into a distinct separate bone, but is gradually produced by the ossification of the body of this bone being continued forwards.

The ARM has only one bone, best known by the *Latin* name of *os humeri* (*a*); which is long, round, and nearly straight.

The upper end of this bone (*b*) is formed into a large round smooth head, whose middle point is not in a straight line with the axis of the bone, but stands obliquely backwards from it.—The extent of the head is distinguished by a circular *fossa* surrounding its base, where the head is united to the bone, and the capsular ligament of the joint is fixed.—Below the fore-part of its base two tubercles stand out: the smallest one, which is situated most to the inside, has the tendon of the *subscapularis* muscle inserted into it.—The larger more external protuberance is divided, at its upper part, into three smooth plain surfaces; into the anterior of which the *musculus supra-spinatus*, into the middle or largest the *infra spinatus*, into the one behind the *teres minor*, is inserted.—Between these two tubercles, exactly in the fore-part of the bone, a deep long *fossa* is formed, for lodging the tendinous head of the *biceps flexor cubiti*; which, after passing, in a manner peculiar to itself, through the cavity of the articulation, is tied down by a tendinous sheath extended across the *fossa*; in which, and in the neighbouring tubercles, are several

(*a*) Ἀκρολίσ, αλίνν, *os brachii*, *armi*, *adjutorium*, *parvum brachium*, *canna brachii*.

(*b*) Ἀροκόλιον.

ral remarkable holes, which are penetrated by the tendinous and ligamentous fibres, and by vessels.—On each side of this *fossa*, as it descends in the *os humeri*, a rough ridge, gently flattened in the middle, runs from the roots of the tubercles.—The tendon of the *pectoral* muscle is fixed into the anterior of these ridges, and the *latissimus dorsi* and *teres major* are inserted into the internal one.—A little behind the lower end of this last, another rough ridge may be observed, where the *coraco-brachialis* is inserted.—From the back-part of the root of the largest tubercle a ridge also is continued, from which the *breviss. extensor cubiti* rises.—This bone is flattened on the inside, about its middle, by the belly of the *biceps flexor cubiti*.—In the middle of this plain surface, the entry of the medullary artery is seen slanting obliquely downwards.—At the fore-side of this plane, the bone rises in a sort of ridge; which is rough, and often has a great many small holes in it, where the tendon of the strong *deltoid* muscle is inserted; on each side of which the bone is smooth and flat, where the *brachialis internus* rises. The exterior of these two flat surfaces is the largest; behind it a superficial spiral channel, formed by the *muscular* nerve and the vessels that accompany it, runs from behind forwards and downwards.—The body of the *os humeri* is flattened behind by the extensors of the fore-arm.—Near the lower end of this bone, a large sharp ridge is extended on its outside; from which the *musculus spinator radii longus*, and the longest head of the *extensor carpi radialis*, rise.—Opposite to this, there is another small ridge, to which the *aponeurotic* tendon, that gives origin to the fibres of the internal and external *brachii* muscles, is fixed; and from a little depression on the fore-side of it, the *pronator radii teres* rises.

The body of the *os humeri* becomes gradually broader towards the lower end, where it has several processes; at the roots of which there is a cavity before, and another behind (*a*). The anterior is divided by a ridge into two: the external, which is the least, receives the end of the *radius*; and the internal receives the *coronoid* process of the *ulna* in the flexions of the fore-arm, while the posterior deep triangular cavity lodges the *olecranon* in the extensions of that member.—The bone betwixt these two cavities is pressed so thin by the processes of the *ulna*, as to appear diaphanous in several

several subjects.—The sides of the posterior cavity are stretched out into two processes, one on each side: these are called *condyles*; from each of which a strong ligament goes out to the bones of the *fore-arm*.—The external *condyle*, which has an oblique direction also forwards in respect of the internal, when the arm is in the most natural posture (*a*), is equally broad, and has an obtuse smooth head rising from it forwards.—From the rough part of the *condyle*, the inferior head of the *bicornis*, the *extensor digitorum communis*, *extensor carpi ulnaris*, *anconæus*, and some part of the *supinator radii brevis*, take their rise; and on the smooth head the upper end of the *radius* plays.—Immediately on the outside of this there is a sinuosity made by the shorter head of the *bicornis* muscle, upon which the *muscular nerve* is placed.—The internal *condyle* is more pointed and protuberant than the external, to give origin to some part of the *flexor carpi radialis*, *pronator radii teres*, *palmaris longus*, *flexor digitorum sublimis*, and *flexor carpi ulnaris*. Between the two *condyles* is the *trochlea*, or pulley; which consists of two lateral protuberances and a middle cavity, that are smooth and covered with cartilage.—When the fore-arm is extended, the tendon of the internal *brachii* muscle is lodged in the fore-part of the cavity of this pulley.—The external protuberance, which is less than the other, has a sharp edge behind; but forwards, this ridge is obtuse, and only separated from the little head already described by a small *fossa*, in which the joined edges of the *ulna* and *radius* move.—The internal protuberance of the pulley is largest and highest; and therefore in the motions of the *ulna* upon it, that bone would be inclined outwards, were it not supported by the *radius* on that side.—Between this internal protuberance and *condyle*, a sinuosity may be remarked where the *ulnar nerve* passes.

The substance and the internal structure of the *os humeri* is the same, and disposed in the same way, as in other long bones.

The round head at the upper end of this bone is articulated with the *glenoid* cavity of the *scapula*; which being superficial, and having long ligaments, allows the arms a free and extensive motion.—These ligaments are, however, considerably strong: for besides the common capsular one, the tendons of the muscles perform the office, and have been described under the name of *ligaments*.—Then the *acromion* and *coracoid* process,

A a

with

with the strong broad ligaments stretched betwixt them, secure the articulation above, where the greatest and most frequent force is applied to thrust the head of the bone out of its place. It is true, that there is not near so strong a defence at the lower part of the articulation; but in the ordinary postures of the arm, that is, so long as it is at an acute angle with the trunk of the body, there cannot be any force applied at this place to occasion a luxation, since the joint is protected so well above.

The motions which the arm enjoys by this articulation are to every side; and by the succession of these different motions a circle may be described. Besides which, the bone performs a small rotation round its own *axis*. But though this can be performed with the round head in all positions; yet as these vary, the effects upon the body of the bone are very different: For if the middle of the head is the centre of rotation, as it is when the arm hangs down by the side, the body of the bone is only moved forwards and backwards; because the *axis* of motion of the head is nearly at right angles with the length of the bone (*a*): whereas, when the arm is raised to right angles with the trunk of the body, the centre of motion, and the axis of the bone, come to be in the same straight line; and therefore the body of the *os humeri* performs the same motion with its head.—Though the motions of the arm seem to be very extensive, yet the larger share of them depends on the motion of the *scapula*.—The lower end of the *os humeri* is articulated with the bones of the fore-arm, and carries them with it in all its motions, but serves as a base on which they perform the motions peculiar to themselves; as shall be described afterwards.

Both the ends of this bone are cartilaginous in a new-born infant; and the large head with the two tubercles, and the *trochlea* with the two *condyles*, become *epiphyses* before they are united to the body of the bone.

The FORE-ARM (*b*) consists of two long bones, the *ulna* and *radius*; whose situation, in respect of each other, is oblique in the least straining or most natural posture; that is, the *ulna* is not directly behind, nor on the outside of the *radius*, but in a middle situation between these two; and the *radius* crosses it.—The situation, however, of these two bones, and of all the other bones of the *superior extremity* that are not yet described,

(a) Hippocrat. de Articul. § 1.

(b) Cubitus; πηχὺς, ὠλεὴν, πυγών, ulna, lacertus.

bed, is frequently altered: and therefore, to shun repetitions, I desire it may be now remarked, that in the remaining account of the *superior extremity*, I understand by the term of *posterior*, that part which is in the same direction with the back of the hand; by *anterior*, that answering to the palm; by *internal*, that on the same side with the thumb; by *external*, the side nearest to the little finger; supposing the hand always to be in a middle position between *pronation* and *supination*.

ULNA (*a*), so named from its being used as a measure, is the longest of the two bones of the fore-arm, and situated on the outside of the *radius*.

At the upper end of the *ulna* are two processes.—The posterior is the largest, and formed like a hook, whose concave surface moves upon the pulley of the *os humeri*, and is called *olecranon* (*b*), or top of the cubit.—The convex back-part of it is rough and scabrous, where the *longus*, *brevis*, and *brachieus externus*, are inserted. The *olecranon* makes it unnecessary that the tendons of the extensor muscles should pass over the end of the *os humeri*; which would have been of ill consequence in the great flexions of this joint, or when any considerable external force is applied to this part (*c*).—The anterior process is not so large, nor does it reach so high, as the one behind; but is sharper at its end, and therefore is named *coronoid*.—Between these two processes a large semicircular or *sigmoid* concavity is left; the surface of which, on each side of a middle rising, is slanting, and exactly adapted to the pulley of the bone of the arm.—Across the middle of it, there is a small sinuosity for lodging mucilaginous glands; where, as well as in a small hollow on the internal side of it, the cartilage that lines the rest of its surface is wanting.—Round the brims of this concavity the bone is rough, where the capsular ligament of the joint is implanted.—Immediately below the *olecranon*, on the back-part of the *ulna*, a flat triangular spongy surface appears, on which we commonly lean.—At the internal side of this, there is a larger hollow surface, where the *musculus anconæus* is lodged; and the ridge at the inside of this gives rise to the *musculus supinator radii brevis*.—Between the top of the ridge

A a 2

and

(*a*) Cubitus, πῦχος ὑπερπῦχον, fovea majus, canna vel arundo major, et inferior brachii.

(*b*) ἄγκυρον, gibber, cubitus, additamentum necatum.

(*c*) Winslow, Exposition Anatomique du Corps Humain, Traité des Os Secs, § 979:

and the *coronoid* process is the semilunar smooth cavity, lined with cartilage; in which, and a ligament extended from the one to the other end of this cavity, the round head of the *radius* plays.—Immediately below it, a rough hollow gives lodging to mucilaginous glands.—Below the root of the *coronoid* process this bone is scabrous and unequal, where the *brachialis internus* is inserted.—On the outside of that we observe a smooth concavity, where the beginning of the *flexor digitorum profundus* sprouts out.

The body of the *ulna* is triangular.—The internal angle is very sharp where the ligament that connects the two bones is fixed: the sides which make this angle are flat and rough, by the action and adhesion of the many muscles which are situated here.—At the distance of one third of the length of the *ulna* from the top, in its fore-part, the passage of the medullary vessels is to be remarked slanting upwards.—The external side of this bone is smooth, somewhat convex; and the angles at each edge of it are blunted by the pressure of the muscles equally disposed about them.

As this bone descends it becomes gradually smaller; so that its lower end terminates in a little head standing on a small neck.—Towards the fore but outer part of which last, an oblique ridge runs, that gives rise to the *pronator radii quadratus*.—The head is round, smooth, and covered with a cartilage on its internal side, to be received into the semilunar cavity of the *radius*; while a *styloid* process (a) rises from its outside, to which is fixed a strong ligament that is extended to the *os cuneiforme* and *pisiforme* of the wrist.—Between the back-part of that internal smooth side and this process, a sinuosity is left for the tendon of the *extensor carpi ulnaris*.—On the fore-part of the root of the process, such another depression may be remarked for the passage of the *ulnar* artery and nerve.—The end of the bone is smooth, and covered with a cartilage.—Between it and the bones of the wrist, a doubly concave moveable cartilage is interposed; which is a continuation of the cartilage that covers the lower end of the *radius*, and is connected loosely to the root of the *styloid* process, and to the rough cavity there, in which mucilaginous glands are lodged.

The *ulna* is articulated above with the lower end of the *os humeri*, where these bones have depressions and protuberances corresponding to each other,

(a) ἡ ἑξωτερικὴ, malleolus externus.

other, so as to allow an easy and secure extension of the fore-arm to almost a straight line with the arm, and flexion to a very acute angle; but by the slanting position of the pully, the lower part of the fore-arm is turned outwards in the extension, and inwards in the flexion (a); and a very small kind of rotation is likewise allowed in all positions, especially when the ligaments are most relaxed by the fore-arm being in a middle degree of flexion.—The *ulna* is also articulated with the *radius* and *carpus*, in a manner to be related afterwards.

RADIUS (b), so called from its imagined resemblance to a spoke of a wheel, or to a weaver's beam, is the bone placed at the inside of the fore-arm. Its upper end is formed into a circular little head, which is hollowed for an articulation with the tubercle at the side of the pully of the *os humeri*; and the half of the round circumference of the head next to the *ulna* is smooth, and covered with a cartilage, in order to be received into the semilunated cavity of that bone.—Below the head, the *radius* is much smaller; therefore this part is named its *cervix*, which is made round by the action of the *supinator radii brevis*.—At the external root of this neck a tuberos process rises; into the outer part of which the *biceps flexor cubiti* is inserted.—From this a ridge runs downwards and inwards, where the *supinator radii brevis* is inserted; and a little below, and behind this ridge, there is a rough scabrous surface, where the *pronator radii teres* is fixed.

The body of the *radius* is not straight, but convex on its internal and posterior surfaces; where it is also made round by the equal pressure of the circumjacent muscles, particularly of the *extensors* of the thumb; but the surfaces next to the *ulna* are flattened and rough, for the origin of the muscles of the hand; and both terminate in a common sharp spine, to which the strong ligament extended betwixt the two bones of the fore-arm is fixed.—A little below the beginning of the plain surface, on its fore-part, where the *flexor* muscle of the last joint of the thumb takes its origin, the passage of the medullary vessels is seen slanting upwards.—The *radius* becomes broader and flatter towards the lower end, especially on its fore-part, where its *pronator quadratus* muscle is situated.

The:

(a) Winslow, Memoires de l'Acad. des Sciences, 1722.

(b) *κερχις, παραπυχιον*, *focile minus*, *canna minor*, *arundo minor*.

The lower end of the *radius* is larger than the superior ; though not in such a disproportion as the upper end of the *ulna* is larger than its lower end.—Its back-part has a flat strong ridge in the middle, and *fossæ* on each side.—In a small groove, immediately on the outside of the ridge, the tendon of the *extensor tertii internodii policis* plays.—In a large one beyond this, the tendons of the *indicator* and of the common *extensor* muscles of the fingers pass.—Contiguous to the *ulna*, there is a small depression made by the *extensor minimi digiti*.—On the inside of the ridge there is a broad depression, which seems again subdivided, where the two tendons of the *bicornis*, or *extensor carpi radialis*, are lodged.—The internal side of this end of the *radius* is also hollowed by the extensors of the first and second joint of the thumb ; immediately above which, a little rough surface shews where the *supinator radii longus* is inserted.—The ridges at the sides of the grooves, in which the tendons play, have an annular ligament fixed to them, by which the several sheaths for the tendons are formed.—The fore-part of this end of the *radius* is also depressed, where the flexors of the fingers and *flexor carpi radialis* pass.—The external side is formed into a semilunated smooth cavity, lined with a cartilage, for receiving the lower end of the *ulna*.—The lowest part of the *radius* is formed into an oblong cavity : in the middle of which is a small transverse rising, gently hollowed, for lodging mucilaginous glands ; while the rising itself is insinuated into the conjunction of the two bones of the wrist that are received into the cavity.—The internal side of this articulation is fenced by a remarkable process (a) of the *radius*, from which a ligament goes out to the wrist, as the *styloid* process of the *ulna* with its ligament guards it on the outside.

- The ends of both the bones of the fore-arm being thicker than the middle, there is a considerable distance between the bodies of these bones ; in the larger part of which, a strong tendinous, but thin ligament, is extended, to give a large enough surface for the origin of the numerous fibres of the muscles situated here, that are so much sunk between the bones, as to be protected from injuries, which they would otherwise be exposed to. But this ligament is wanting near the upper end of the fore-arm,

(a) Malleolus internus, processus styloides.

arm, where the *supinator radii brevis* and *flexor digitorum profundus* are immediately connected (a).

Both ends of the bones of the fore-arm are first cartilages, and then *epiphyses*, in children.

As the head of the *radius* receives the tubercle of the *os humeri*, it is not only bended and extended along with the *ulna*, but may be moved round its *axis* in any position; and that this motion round its *axis* may be sufficiently large, the ligament of the articulation is extended farther down than ordinary on the neck of this bone, before it is connected to it; and it is very thin at its upper and lower part, but makes a firm ring in the middle.—This bone is also joined to the *ulna* by a double articulation: for above, a tubercle of the *radius* plays in a socket of the *ulna*; whilst below, the *radius* gives the socket, and the *ulna* the tubercle. But then the motion performed in these two is very different: for, at the upper end, the *radius* does no more than turn round its axis; while, at the lower end, it moves in a sort of *cycloid* upon the round part of the *ulna*; and as the hand is articulated and firmly connected here with the *radius*, they must move together.—When the palm is turned uppermost, the *radius* is said to perform the *supination*; when the back of the hand is above, it is said to be *prone*. But then the quickness and large extent of these two motions are assisted by the *ulna*, which, as was before observed, can move with a kind of small rotation on the sloping sides of the pulley. This lateral motion, though very inconsiderable in the joint itself, is conspicuous at the lower end of such a long bone; and the strong ligament connecting this lower end to the *carpus*, makes the hand more readily to obey these motions.—When we design a large circular turn of our hand, we increase it by the rotation of the *os humeri*, and sometimes employ the spine and *inferior extremities* to make these motions of pronation or supination of the hand large enough.

The HAND (b) comprehends all from the joint of the wrist to the points of the fingers. Its back-part is convex, for greater firmness and strength; and it is concave before, for containing more surely and conveniently such bodies as we take hold of.—One half of the hand has an obscure motion in comparison of what the other has, and serves as a base to the
moveable

(a) Weitbrecht, Syndesmolog. fig. 10, 11.

(b) Ἀρροχίη, *summa manus*.

moveable half; which can be extended back very little farther than to a straight line with the fore-arm, but can be considerably bended forwards.

As the bones that compose the hand are of different shapes and uses, while several of them that are contiguous agree in some general characters; the hand is, on this account, commonly divided into the *carpus*, *metacarpus*, and *fingers*; among which last the thumb is reckoned,

The *CARPUS* (*a*) is composed of eight small spongy bones, situated at the upper part of the hand. I shall describe each of these bones, under a proper name taken from their figure (*b*): because the method of ranging them by numbers leaves anatomists too much at liberty to debate very idly, which ought to be preferred to the first number; or, which is worse, several, without explaining the order they observe, differently apply the same numbers, and so confound their readers.—But, that the description of these bones may be in the same order as they are found in the generality of anatomical books, I shall begin with the range of bones that are concerned in the moveable joint of the wrist, or are connected to the fore-arm; and shall afterwards consider the four that support the thumb and *ossa metacarpi* of the fingers.

The eight bones of the carpus are, *os scaphoides*, *lunare*, *cuneiforme*, *pisiforme*, *trapezium*, *trapezoides*, *magnum*, *unciforme*.

The *scaphoides* is situated most internally of those that are articulated with the fore-arm.—The *lunare* is immediately on the outside of the former.—The *cuneiforme* is placed still more externally, but does not reach so high up as the other two.—The *pisiforme* stands forwards into the palm from the *cuneiforme*.—The *trapezium* is the first of the second row, and is situated betwixt the *scaphoides* and first joint of the thumb.—The *trapezoides* is immediately on the outside of the *trapezium*.—The *os magnum* is still more external.—The *unciforme* is farther to the side of the little finger.

Os scaphoides (*c*) is the largest of the eight except one. It is convex above, concave and oblong below; from which small resemblance of a boat it has got its name.—Its smooth convex surface is divided by a rough middle *fossa*, which runs obliquely cross it.—The upper largest
division

(*a*) Κερίς, brachiale, prima palmæ pars, rafetta.

(*b*) Lyser. Cult. Anat. lib. 5. cap. 2.

(*c*) Κοτυλοειδής, naviculare.

division is articulated with the *radius*.—Into the *fossa* the common ligament of the joint of the wrist is fixed; and the lower division is joined to the *trapezium* and *trapezoides*.—The concavity receives more than an half of the round head of the *os magnum*.—The external side of this hollow is formed into a femilunar plane, to be articulated with the following bone.—The internal posterior and anterior edges are rough, for fixing the ligaments that connect it to the surrounding bones.

Os lunare (*a*) has a smooth convex upper surface, by which it is articulated with the *radius*.—The internal side, which gives the name to the bone, is in the form of a crescent, and is joined with the *scaphoid*;—the lower surface is hollow, for receiving part of the head of the *os magnum*.—On the outside of this cavity is another smooth, but narrow oblong sinuosity, for receiving the upper end of the *os unciforme*:—On the outside of which a small round convexity is found, for its connection with the *os cuneiforme*.—Between the great convexity above, and the first deep inferior cavity, there is a rough *fossa*, in which the circular ligament of the joint of the wrist is fixed.

Os cuneiforme (*b*) is broader above, and towards the back of the hand, than it is below and forwards; which gives it the resemblance of a wedge.—The superior slightly convex surface is included in the joint of the wrist, being opposed to the lower end of the *ulna*.—Below this the cuneiform bone has a rough *fossa*, wherein the ligament of the articulation of the wrist is fixed.—On the internal side of this bone, where it is contiguous to the *os lunare*, it is smooth and slightly concave.—Its lower surface, where it is contiguous to the *os unciforme*, is oblong, somewhat spiral, and concave.—Near the middle of its anterior surface a circular plane appears, where the *os pisiforme* is sustained.

Os pisiforme (*c*) is almost spherical, except one circular plane, or slightly hollow surface, which is covered with cartilage for its motion on the cuneiform bone, from which its whole rough body is prominent forwards into the palm; having the tendon of the *flexor carpi ulnaris*, and a ligament from the *styloid* process of the *ulna*, fixed to its upper part; the *transverse* ligament of the wrist is connected to its internal side; ligaments

B b extended ●

(a) Lunatum.

(b) Triquetrum.

(c) Cartilaginofum, subrotundum, rectum.

extended to the *unciform* bone, and to the *os metacarpi* of the little finger, are attached to its lower part; the *abductor minimi digiti* has its origin from its fore-part; and, at the internal side of it, a small depression is formed, for the passage of the ulnar nerve.

Trapezium (a) has four unequal sides and angles in its back-part, from which it has got its name.—Above, its surface is smooth, slightly hollowed, and semicircular, for its conjunction with the *os scaphoides*.—Its external side is an oblong concave square, for receiving the following bone.—The inferior surface is formed into a pulley; the two protuberant sides of which are external and internal. On this pulley the first bone of the thumb is moved.—At the external side of the external protuberance, a small oblong smooth surface is formed by the *os metacarpi indicis*.—The fore-part of the *trapezium* is prominent in the palm; and, near to the external side, has a sinuosity in it, where the tendon of the *flexor carpi radialis* is lodged; on the ligamentous sheath of which the tendon of the *flexor tertii internodii pollicis* plays: And still more externally the bone is scabrous, where the *transverse* ligament of the wrist is connected, the *abductor* and *flexor primi internodii pollicis* have their origin, and ligaments go out to the first bone of the thumb.

Os trapezoides (b), so called from the irregular quadrangular figure of its back-part, is the smallest bone of the wrist, except the *pisiforme*.—The figure of it is an irregular cube.—It has a small hollow surface above, by which it joins the *scaphoides*; a long convex one internally, where it is contiguous to the *trapezium*; a small external one, for its conjunction with the *os magnum*; and an inferior convex surface, the edges of which are however so raised before and behind, that a sort of pulley is formed, where it sustains the *os metacarpi indicis*.

Os magnum (c), so called because it is the largest bone of the *carpus*, is oblong, having four quadrangular sides, with a round upper end, and a triangular plain one below.—The round head is divided by a small rising, opposite to the connection of the *os scaphoides* and *lunare*, which together form the cavity for receiving it.—On the inside a short plain surface joins the *os magnum* to the *trapezoides*.—On the outside is a long narrow concave

(a) *Os cubiforme, trapezoides, multangulum majus.*

(b) *Trapezium, multangulum minus.*

(c) *Maximum, capitatum.*

cave surface, where it is contiguous to the *os unciforme*.—The lower end, which sustains the metacarpal bone of the middle finger, is triangular, slightly hollowed, and farther advanced on the internal side than on the external, having a considerable oblong depression made on the advanced inside by the metacarpal bone of the fore-finger; and generally there is a small mark of the *os metacarpi digiti annularis* on its external side.

Os unciforme (a) has got its name from a thin broad process that stands out from it forwards into the palm, and is hollow on its inside, for affording passage to the tendons of the flexors of the fingers. To this process also the transverse ligament is fixed, that binds down and defends these tendons; and the *flexor* and *abductor* muscles of the little finger have part of their origin from it.—The upper plain surface is small, convex, and joined with the *os lunare*:—The internal side is long, and slightly convex, adapted to the contiguous *os magnum*:—The external surface is oblique, and irregularly convex, to be articulated with the cuneiform bone:—The lower end is divided into two concave surfaces; the external is joined with the metacarpal bone of the little finger, and the internal one is fitted to the metacarpal bone of the ring-finger.

In the description of the preceding eight bones, I have only mentioned those plain surfaces covered with cartilage, by which they are articulated to each other, or to some other bones, except in some few cases, where something extraordinary was to be observed; and I have designedly omitted the other rough surfaces, lest, by crowding too many words in the description of such small bones, the whole should be unintelligible: But these scabrous parts of the bones may easily be understood, after mentioning their figure, if it is observed, that they are generally found only towards the back or palm of the hand; that they are all plain, larger behind than before; and that they receive the different ligaments, by which they are either connected to neighbouring bones, or to one another; for these ligaments cover all the bones, and are so accurately applied to them, that, at first view, the whole *carpus* of a recent subject appears one smooth bone (b).

B b 2

As

(a) Cuneiforme.

(b) Galen de Ufu Part. lib. 2. cap. 8. For a particular description of these ligaments, see Weitbrecht, Syndesmolog. p. 35,—68.

As the surfaces of these bones are largest behind, the figure of the whole conjoined must be convex there, and concave before; which concavity is still more increased by the *os pisiforme*, and process of the *os unciforme*, standing forwards on one side, as the *trapezium* does on the other: And the bones are securely kept in this form by the broad strong transverse ligament connected to those parts of them that stand prominent into the palm of the hand.—The convexity behind renders the whole fabric stronger, where it is most exposed to injuries; and the large anterior hollow is necessary for a safe passage to the numerous vessels, nerves, and tendons of the fingers.

The substance of these bones is spongy and cellular, but strong in respect of their bulk.

The three first bones of the *carpus* make an oblong head, by which they are articulated with the cavity at the lower ends of the bones of the fore-arm, so as to allow motion to all sides; and, by a quick succession of these motions, they may be moved in a circle. But as the joint is oblong, and therefore the two dimensions are unequal, no motion is allowed to the *carpus* round its axis, except what it has in the pronation and supination along with the *radius*.—The articulation of the first three bones of the superior row, with the bones of the inferior, is such as allows of motion, especially backwards and forwards; to the security and easiness of which, the reception of the *os magnum* into the cavity formed by the *scaphoides* and *lunare* contributes considerably: And the greatest number of the muscles that serve for the motion of the wrist on the *radius*, being inserted beyond the conjunction of the first row of bones with the second, act equally on this articulation as they do on the former; but the joint formed with the *radius* being the most easily moved, the first effect of these muscles is on it, and the second row of the *carpus* is only moved afterwards. By this means a larger motion of the wrist is allowed than otherwise it could have had safely: for if as large motion had been given to one joint, the angle of flexion would have been very acute, and the ligaments must have been longer than was consistent with the firmness and security of the joint.—The other articulations of the bones here being by nearly plain surfaces, scarce allow of any more motion, because of the strong connecting ligaments, than to yield a little, and so elude the force

force of any external power; and to render the back of the wrist a little more flat, or the palm more hollow, on proper occasions. The articulations of the thumb and metacarpal bones shall be examined afterwards.

The uses of the *carpus* are to serve as a base to the hand, to protect its tendons, and to afford it a free large motion.

All the bones of the *carpus* are in a cartilaginous state at the time of birth.

On account of the many tendons that pass upon the lower end of the fore-arm and the *carpus*, and of the numerous ligaments of these tendons and of the bones, which have lubricating liquors supplied to them, the pain of sprains here is acute, the parts take long time to recover their tone, and their swellings are very obstinate.

METACARPUS (*a*) consists of four bones which sustain the fingers.—Each bone is long and round, with its ends larger than its body.—The upper end, which some call the base, is flat and oblong, without any considerable head or cavity; but it is, however, somewhat hollowed for the articulation with the *carpus*: It is made flat and smooth on the sides where these bones are contiguous to each other.—Their bodies are flattened on their back-part by the tendons of the extensors of the fingers.—The anterior surface of these bodies is a little concave, especially in their middle; along which a sharp ridge stands out, which separates the *muculi interossei* placed on each side of these bones, which are there made flat and plain by these muscles.

Their lower ends are raised into large oblong smooth heads, whose greatest extent is forwards from the axis of the bone.—At the fore-part of each side of the root of each of these heads, one or two tubercles stand out, for fixing the ligaments that go from one metacarpal bone to another, to preserve them from being drawn asunder.—Round the heads a rough ring may be remarked, for the capsular ligaments of the first joints of the fingers to be fixed to; and both sides of these heads are flat, by pressing on each other.

The substance of the metacarpal bones is the same with that of all long bones.

At

(*a*) Κτίς, προκαρπιον, σπινος, αυστηρον, κτινιον, post brachiale, pectus, palma, pecten..

At the time of birth, these bones are cartilaginous at both ends, which afterwards become *epiphyses*.

The metacarpal bones are joined above to the *ossa carpi*, and to each other by nearly plain surfaces. These connections are not fit for large motions.—The articulation of their round heads at the lower ends with the cavities of the first bones of the fingers, is to be taken notice of hereafter.

The concavity on the fore-part of these metacarpal bones, and the placing their bases on the arched *carpus*, cause them to form a hollow in the palm of the hand, which is useful often to us.—The spaces between them lodge muscles, and their small motion makes them fit supporters for the fingers to play on.

Though the *ossa metacarpi* so far agree, yet they may be distinguished from each other by the following marks.

The *os metacarpi indicis* is generally the longest.—Its base, which is articulated with the *os trapezoides*, is hollow in the middle.—The small ridge on the internal side of this oblong cavity is smaller than the one opposite to it, and is made flat on the side by the *trapezium*.—The exterior ridge is also smooth, and flat on its outside, for its conjunction with the *os magnum*; immediately below which a semicircular smooth flat surface shows the articulation of this to the second metacarpal bone.—The back-part of this base is flattened where the long head of the *extensor carpi radialis* is inserted; and its fore-part is prominent, where the tendon of the *flexor carpi radialis* is fixed.—The external side of the body of this bone is more hollowed by the action of muscles than the internal.—The tubercle at the internal root of its head is larger than the external.—Its base is so firmly fixed to the bone it is connected with, that it has no motion.

Os metacarpi medii digiti is generally the second in length: but often it is as long as the former; sometimes it is longer; and frequently it appears only to equal the first by the *os magnum* being farther advanced downwards than any other bone of the wrist—Its base is a broad superficial cavity, flanting outwards; the internal posterior angle of which is so prominent, as to have the appearance of a process.—The internal side of this base is made plain in the same way as the external side of the former bone, while its external side has two hollow circular surfaces, for joining
the

the third metacarpal bone; and between these surfaces there is a rough *fossa*, for the adhesion of a ligament, and lodging mucilaginous glands.—The shorter head of the *bicornis* is inserted into the back-part of this base. The two sides of this bone are almost equally flatted; only the ridge on the fore-part of the body inclines outwards. The tubercles at the fore-part of the root of the head are equal. The motion of this bone is very little more than the first metacarpal one has; and therefore these two firmly resist bodies pressed against them by the thumb, or fingers, or both.

Os metacarpi digiti annularis is shorter than the second metacarpal bone. Its base is semicircular and convex, for its conjunction with the *os unciniforme*.—On its internal side are two smooth convexities, and a middle *fossa*, adapted to the second metacarpal bone.—The external side has a triangular smooth concave surface to join it with the fourth one. The anterior ridge of its body is situated more to the out than the inside.—The tubercles near the head are equal.—The motion of this third metacarpal bone is greater than the motion of the second.

Os metacarpi minimi digiti is the smallest and sharpest.—Its base is irregularly convex, and rises slanting outwards.—Its internal side is exactly adapted to the third metacarpal bone.—The external has no smooth surface, because it is not contiguous to any other bone; but it is prominent where the *extensor carpi ulnaris* is inserted.—As this *metacarpal* bone is furnished with a proper moving muscle, has the plainest articulation, is most loosely connected and least confined, it not only enjoys a much larger motion than any of the rest, but draws the third bone with it, when the palm of the hand is to be made hollow by its advancement forwards, and by the prominence of the thumb opposite to it.

The THUMB and four FINGERS are each composed of three long bones.

The *thumb* (a) is situated obliquely in respect of the fingers, neither opposite directly to them, nor in the same plane with them.—All its bones are much thicker and stronger in proportion to their length, than the bones of the fingers are: which was extremely necessary, since the thumb counteracts all the fingers.

The first bone of the thumb has its base adapted to the double pulley
of

(a) Ἀντιχείρ, δίκονδύλος, *magnus digitus, promanus.*

of the *trapezium*: for in viewing it from one side to the other, it appears convex in the middle; but when considered from behind forwards, it is concave there.—The edge at the fore-part of this base is produced farther than any other part; and round the back-part of the base a rough *fossa* may be seen, for the connection of the ligaments of this joint.—The body and head of this bone are of the same shape as the *ossa metacarpi*; only that the body is shorter, and the head flatter, with the tubercles at the fore-part of its root larger.

The articulation of the upper end of this bone is uncommon: for tho' it has protuberances and depressions adapted to the double pulley of the *trapezium*, yet it enjoys a circular motion, as the joints do where a round head of one bone plays in the orbicular socket of another; only it is somewhat more confined and less expeditious, but stronger and more secure, than such joints generally are.

This bone of children is in the same state with the metacarpal bones.

The second bone of the thumb has a large base formed into an oblong cavity, whose greatest length is from one side to the other.—Round it several tubercles may be remarked, for the insertion of ligaments.—Its body is convex, or a half round behind; but flat before, for lodging the tendon of the long flexor of the thumb, which is tied down by ligamentous sheaths that are fixed on each side to the angle at the edge of this flat surface. The lower end of this second bone has two lateral round protuberances, and a middle cavity, whose greatest extent of smooth surface is forwards.

The articulation and motion of the upper end of this second bone is as singular as that of the former.—For its cavity being joined to the round head of the first bone, it would seem at first view to enjoy motion in all directions; yet because of the strength of its lateral ligaments, oblong figure of the joint itself, and mobility of the first joint, it only allows flexion and extension; and these are generally much confined.

The third bone of the thumb is the smallest, with a large base, whose greatest extent is from one side to the other.—This base is formed into two cavities and a middle protuberance, to be adapted to the pulley of the former bone. Its body is rounded behind; but is flatter than in the former bone, for sustaining the nail. It is flat and rough before, by the
insertion

infertion of the *flexor tertii internodii*. This bone becomes gradually smaller, till near the lower end, where it is a little enlarged, and has an oval scabrous edge.

The motion of this third bone is confined to flexion and extenſion.

The orderly diſpoſition of the bones of the *fingers* into three rows, has made them generally obtain the name of three *phalanges* (*a*). All of them have half-round convex ſurfaces, covered with an *aponeuroſis*, formed by the tendons of the *extenſors*, *lumbricales*, and *interoffei*, and placed directly backwards, for their greater ſtrength; and their flat concave part is forwards, for taking hold more ſurely, and for lodging the tendons of the flexor muſcles. The ligaments for keeping down theſe tendons are fixed to the angles that are between the convex and concave ſides.

The bones of the firſt *phalanx* (*b*) of the fingers anſwer to the deſcription of the ſecond bone of the thumb; only that the cavity in their baſe is not ſo oblong, nor is their motion on the metacarpal bones ſo much confined: for they can be moved laterally or circularly; but have no rotation, or a very ſmall degree of it, round their axis.

Both the ends of this firſt *phalanx* are in a cartilaginous ſtate at the birth; and the upper one is afterwards affixed in form of an *epiphyſe*.

The ſecond bone (*c*) of the fingers has its baſe formed into two lateral cavities and a middle protuberance, while the lower end has two lateral protuberances and a middle cavity; therefore it is joined at both ends in the ſame manner, which none of the bones of the thumb are.

This bone is in the ſame condition with the former in children.

The third bone (*d*) differs nothing from the deſcription of the third bone of the thumb, excepting in the general diſtinguiſhing marks; and therefore the ſecond and third *phalanx* of the fingers enjoy only flexion and extenſion.

The upper end of this third *phalanx* is a cartilage in a ripe child; and is only an *epiphyſe* after, till the full growth of the body.

All the difference of the *phalanges* of the ſeveral fingers conſiſts in their magnitude.—The bones of the *middle finger* (*e*) being the longeſt and lar-

C c

geſt,

(*a*) Scytalidæ, internodia, ſcuticula, agmina, acies, condyli, articuli.

(*b*) Προκονδυλοι.

(*c*) -Κονδυλοι.

(*d*) Μετακονδυλοι, ριζωνυχια.

(*e*) Καταπυγων, οφρακιλος, infamis, impudicus, verpus, famoſus, obſcœnus.

gest,—those of the *fore-finger* (*a*) come next to that in thickness, but not in length; for those of the *ring-finger* (*b*) are a little longer. The *little finger* (*c*) has the smallest bones: which disposition is the best contrivance for holding the largest bodies; because the longest fingers are applied to the middle largest periphery of such substances as are of a spherical figure (*d*).

The uses of all the parts of our *superior extremities* are so evident in the common actions of life, that it is needless to enumerate them here; and therefore I shall proceed to the last part of the skeleton. Only, lest I should seem to have forgot the small bones at the joints of the hand, I desire now to refer to the description of them, under the common title of *sesamoid bones*, which I have placed after the bones of the feet.

Of the INFERIOR EXTREMITIES.

THE INFERIOR EXTREMITIES depend from the *acetabula* of the *ossa innominata*; and are commonly divided into three parts, viz. the thigh, leg, and foot.

The THIGH (*e*) has only one bone; which is the longest of the body, and the largest and strongest of any of the cylindrical bones. The situation of it is not perpendicular; for the lower end is inclined considerably inwards: so that the knees are almost contiguous, while there is a considerable distance between the thigh-bones above; which is of good use to us, since sufficient space is thereby left for the external parts of generation, the two great *cloacæ* of urine and *fæces*, and for the large thick muscles that move the thigh inwards. And at the same time this situation of the thigh-bones renders our progression quicker, surer, straighter, and in less room: for had the knees been at a greater distance from each other, we must have been obliged to describe some part of a circle with the trunk

(a) Δεικτικός, indicator, λιχανός, demonstrativus, salutaris.

(b) ἰατρικός, παραμیسος, δακτυλιώτης, ἐπιβατής, annularis, medicus, cordis digitus.

(c) Μυωψ, ωτίτις, auricularis, minimus.

(d) Galen de Ufu part. lib. 1. cap. 24.

(e) Μηρον, femur, coxa, agis, anchæ os, crus, femur.

trunk of our body in making a long step; and when one leg was raised from the ground, our centre of gravity would have been too far from the base of the other, and we should consequently have been in hazard of falling: so that our steps would neither have been straight nor firm; nor would it have been possible to walk in a narrow path, had our thigh-bones been otherwise placed. In consequence, however, of the weight of the body bearing so obliquely on the joint of the knee, by this situation of the thigh-bones, weak rickety children become in-knee'd.

The upper end of the thigh-bone is not continued in a straight line with the body of it, but is set off obliquely inwards and upwards; whereby the distance here between these two bones, at their upper part, is considerably increased.—This end is formed into a large smooth round head (*a*), which is the greater portion of a sphere unequally divided.—Towards its lower internal part, a round rough spongy pit is observable, where the strong ligament, commonly, but unjustly, called the *round one*, is fixed, to be extended from thence to the lower internal part of the receiving cavity; where it is considerably broader than near to the head of the thigh-bone.—The small part below the head, called the *cervix*, of the *os femoris*, has a great many large holes, into which the fibres of the strong ligament, continued from the capsular, enter, and are thereby surely united to it: and round the root of the neck, where it rises from the bone, a rough ridge is found, where the capsular ligament of the articulation itself is connected.—Below the back-part of this root, the large unequal protuberance, called *trochanter major* (*b*), stands out: the external convex part of which is distinguished into three different surfaces; whereof the one on the fore-part is scabrous and rough, for the insertion of the *glutæus minimus*; the superior one is smooth, and has the *glutæus medius* inserted into it; and the one behind is made flat and smooth by the tendon of the *glutæus maximus* passing over it.—The upper edge of this process is sharp and pointed at its back-part, where the *glutæus medius* is fixed; but forwards it is more obtuse, and has two superficial pits formed in it: Into the superior of these, the *pyriformis* is implanted; and the *obturator internus* and *gemini* are fixed into the lower one.—From the backmost prominent part of this great *trochanter*, a rough ridge runs

C c 2

backwards

(*a*) Vertebrium.(*b*) Γλωττος, rotator natis, malum granatum testiculorum.

backwards and downwards, into which the *quadratus* is inserted.—In the deep hollow, at the internal upper side of this ridge, the *obturator externus* is implanted.—More internally, a conoid process, called *trochanter minor* (a), rises for the insertion of the *musculus psoas* and *iliacus internus*; and the *pectineus* is implanted into a rough hollow below its internal root. The muscles inserted into these two processes being the principal instruments of the rotatory motion of the thigh, have occasioned the name of *trochanters* to the processes.—The tendons that are fixed into or pass over the great *trochanter*, cause bruises by falls on this part to be attended with great pain and weakness of the limb, which generally remain long.

The body of the *os femoris* is convex on the fore-part, and made hollow behind, by the action of the muscles that move it and the leg, and for the convenience of sitting, without bearing too much on these muscles; and probably the weight of the legs depending from the thighs in that posture, contributes to this curvature.—The fore-part of the thigh-bone is a little flattened above by the beginning of the *cruræus* muscle, as it is also below by the same muscle and the *rectus*.—Its external surface is likewise made flat below by the *vastus externus*, where it is separated from the former by an obtuse ridge.—The *vastus internus* depresses a little the lower part of the internal surface.—The posterior concave surface has a ridge rising in its middle, commonly called *linea aspera*, into which the *triceps* is inserted; and the short head of the *biceps flexor tibiæ* rises from it.—At the upper part of it, the medullary vessels enter by a small hole that runs obliquely upwards.—A little above which there is a rough *fossa* or two, where the tendon of the *glutæus maximus* is fixed.—The lower end of the *linea aspera* divides into two, which descend towards each side.—The two *vasti* muscles have part of their origin from these ridges; and the long tendon of the *triceps* is fixed to the internal by means of part of the *fascia aponeurotica* of the thigh.—Near the beginning of the internal ridge, there is a discontinuation of the ridge, where the crural artery passes through the *aponeurosis*.—Between these two rough lines, the bone is made flat by the large blood-vessels and nerves which pass upon it; and near the end of each of these ridges a small smooth protuberance may often be remarked, where the two heads of the external *grastrocnemius* muscle take their

their rise, and where sesamoid bones are sometimes found (*a*); and from the fore-part of the internal tubercle a strong ligament is extended to the inside of the *tibia*.

The lower end of the *os femoris* is larger than any other part of it, and is formed into a great protuberance on each side, called its *condyles*; between which a considerable cavity is found, especially at the back-part, in which the crural vessels and nerves lie immersed in fat.—The internal condyle is longer than the external, which must happen from the oblique position of this bone, to give less obliquity to the leg. Each of these processes seems to be divided in its plain smooth surface. The mark of division on the external is a notch, and on the internal a small protuberance. The fore-part of this division, on which the *rotula* moves, is formed like a pulley, the external side of which is highest. Behind, there are two oblong large heads, whose greatest extent is backwards, for the motion of the *tibia*: And from the rough cavity between them, but near to the base of the internal condyle, the strong ligament, commonly called the *cross* one, has its rise; a little above which, a rough protuberance gives insertion to the tendon of the *triceps*.—The condyles, both on the outer and inner side of the knee, are made flat by the muscles passing along them.—On the back-part of the internal, a slight depression is made by the tendons of the *gracilis* and *sartorius*: And, on the external, such another is formed by the *biceps flexor cruris*; behind which, a deep *fossa* is to be observed, where the *popliteus* muscle has its origin.—From the tubercle immediately before this cavity, a strong round ligament goes out to the upper part of the *fibula*.—Round this lower end of the thigh-bone, large holes are found, into which the ligaments for the security of the joint are fixed, and blood-vessels pass to the internal substance of the bone.

All the processes of the *femur* are cartilaginous in new-born children, and afterwards become small *apophyses*, with large *epiphyses*.

The thigh-bone being articulated above with the *acetabulum* of the *ossa innominata*, which affords its round head a secure and extensive play, can be moved to every side; but is restrained in its motion outwards, by the high brims of the cavity, and by the *round* ligament; for otherwise the head of the bone would have been frequently thrust out at the breach of the

(a). Vesal. lib. 1. cap. 28. & 30.

the brims on the inside, which allows the thigh to move considerably inwards.—The body of this bone enjoys little or no rotatory motion, though the head most commonly moves round its own axis; because the oblique progress of the neck and head from the bone is such, that the rotatory motion of the head can only bring the body of the bone forwards and backwards: Nor is this head, as in the arm, ever capable of being brought to a straight direction with its body; so far, however, as the head can move within the cavity backwards and forwards, the rest of the bone may have a partial rotation.—When the thigh-bone resists the actions of its muscles more than the trunk of the body can then do, as in standing, these muscles have their effect on the trunk, causing it to bend forward, raising it up, inclining it to the one or the other side, twisting it obliquely, &c. which the rolling of the *acetabula* of the *ossa innominata* on the round heads of the thigh-bones is well fitted for.—The *os femoris* is articulated below to the *tibia* and *rotula* in the manner afterwards to be described.

The nearness of the small neck to the round head of the thigh-bone, and its upper end being covered with very thick muscles, make greater difficulty in distinguishing between a luxation and fracture here, than in any other part of the body.

The LEG (*a*) is composed, according to the common account, of two bones, *tibia* and *fibula*: though it seems to have a very good title to a third, the *rotula*; which bears a strong analogy to the *olecranon* of the *ulna*, and moves always with the other two.

TIBIA (*b*), so called from its resemblance to an old musical pipe or flute, is the long thick triangular bone, situated at the internal part of the leg, and continued in almost a straight line from the thigh-bone.

The upper end of the *tibia* is large, bulbous, and spongy; and is divided into two cavities, by a rough irregular protuberance (*a*), which is hollow at its most prominent part, as well as before and behind. The anterior of the two ligaments that compose the great *cross* one, is inserted into the middle cavity, and the depression behind receives the posterior ligament.

(*a*) Κνημη, *crus*, *tibia*.

(*b*) Προκνημιον, οντικνημιον, *focile majus*, *arundo major*, *canna major*, *canna domestica cruris*.

(*c*) Διαρυστις, εξοχη πυροχοανκρωδης, *tuber*, *tuberculum*.

ligament.—The two broad cavities at the sides of this protuberance are not equal: for the internal is oblong and deep, to receive the internal *condyle* of the thigh-bone; while the external is more superficial and rounder, for the external *condyle*.—In each of these two cavities of a recent subject, a femilunar cartilage is placed, which is thick at its convex edge, and becomes gradually thinner towards the concave or interior edge.—The middle of each of these cartilages is broad, and the ends of them turn narrower and thinner as they approach the middle protuberance of the *tibia*.—The thick convex edge of each cartilage is connected to the capsular and other ligaments of the articulation; but so near to their rise from the *tibia*, that the cartilages are not allowed to change place far; while the narrow ends of the cartilages, becoming almost ligaments, are fixed at the insertion of the strong cross ligament into the *tibia*, and seem to have their substance united with it; therefore a circular hole is left between each cartilage and the ligament, in which the most prominent convex part of each condyle of the thigh-bone moves.—The circumference of these cavities is rough and unequal, for the firm connection of the ligaments of the joint.—Immediately below the edge, at its back-part, two rough flattened protuberances stand out: Into the internal, the tendon of the *femimembranosus* muscle is inserted; and a part of the cross ligament is fixed to the external.—On the outside of this last tubercle, a smooth slightly hollowed surface is formed by the action of the *popliteus* muscle.

Below the fore-part of the upper end of the *tibia*, a considerable rough protuberance (*a*) rises, to which the strong tendinous ligament of the *rotula* is fixed.—On the internal side of this, there is a broad, scabrous, slightly hollowed surface, to which the internal long ligament of the joint, the *aponeurosis* of the *vastus internus*, and the tendons of the *femineuriosus*, *gracilis*, and *sartorius*, are fixed.—The lowest part of this surface is therefore the place where the *tibia* ought to be sawed through in an amputation, so as not to have too long and troublesome a stump, and, at the same time, to preserve its motions, by saving the proper muscles.—Below the external edge of the upper end of the *tibia*, there is a circular flat surface, covered in a recent subject with cartilage, for the articula-

tion.

(a) Ἀντικνημικόν, anterior tuber.

tion of the *fibula*;—between which and the anterior knob, there is a rough hollow, from which the *tibialis anticus*, and *extensor digitorum longus*, take their origin.—From the smooth flat surface, a ridge runs obliquely downwards and inwards, to give rise to part of the *solæus*, *tibialis posticus*, and *flexor digitorum longus*, and insertion to the *aponeurosis* of the *semimembranosus* which covers the *popliteus*, and to some of the external fibres of this last named muscle.—At the inside of this ridge an oblique plain surface is left, where the greatest part of the *musculus popliteus* is inserted.—The remaining body of the *tibia* is triangular.—The anterior angle is very sharp, and is commonly called the *spine* or *shin* (*a*). This ridge is not straight; but turns first inwards, then outwards, and lastly inwards again.—The plain internal side is smooth and equal, being little subjected to the actions of muscles; but the external side is hollowed above by the *tibialis anticus*, and below by the *extensor digitorum longus* and *extensor pollicis longus*.—The two angles behind these sides are rounded by the action of the muscles;—the posterior side comprehended between them is not so broad as those already mentioned, but is more oblique and flatted by the action of the *tibialis posticus* and *flexor digitorum longus*. Some way above the middle of the bone, the internal angle terminates, and the bone is made round by the pressure of the *musculus solæus*. Near to this, the passage of the medullary vessels is seen slanting obliquely downwards.

The lower end of the *tibia* is made hollow, but so as a small protuberance rises in the middle.—The internal side of this cavity, which is smooth, and in a recent subject is covered with cartilage, is produced into a considerable process, commonly named *malleolus internus* (*b*); the point of which is divided by a notch, and from it ligaments are sent out to the foot.—We ought to observe here, that this internal *malleolus* is situated more forwards than the internal condyle of the upper end of this bone; which is necessary to be remembered in reducing a fracture of the leg (*c*).—The external side of this end of the *tibia* has a rough irregular femilunar cavity formed in it, for receiving the lower end of the *fibula*.—The posterior side has two lateral grooves, and a small middle protuberance.

(*a*) *Ἀκρότατος*, spina, crea, linea prima tibiæ, angulus acutus.

(*b*) *Σφυρακίον*, talus, clavicula, clavilla interior, clavilla domestica.

(*c*) Winslow, Exposition Anatomique des Os secs, sect. 865.

rance. In the internal depression, the tendons of the *musculus tibialis posterior* and *flexor digitorum longus* are lodged; and in the external, the tendon of the *flexor longus pollicis* plays.—From the middle protuberance, ligamentous sheaths go out, for tying down these tendons.

The articulations and motions of the *tibia* shall be explained after all the three bones of the leg are described.

Both the ends of the *tibia* are cartilages at birth, and become afterwards *epiphyses*.

FIBULA (*a*) is the small long bone, placed on the outside of the leg, opposite to the external angle of the *tibia*; the shape of it is irregularly triangular.

The head of the *fibula* has a superficial circular cavity formed on its inside, which, in a recent subject, is covered with a cartilage, but so closely connected to the *tibia* by ligaments, as to allow only a small motion backwards and forwards.—This head is protuberant and rough on its outside, where a strong round ligament and the *musculus biceps* are inserted; and, below the back-part of its internal side, a tubercle may be remarked, that gives rise to the strong tendinous part of the *soleus* muscle.

The body of this bone is a little crooked inwards and backwards, which figure is owing to the actions of the muscles; but is still further increased by nurses, who often hold children carelessly by the legs.—The sharpest angle of the *fibula* is forwards, on each side of which the bone is considerably, but unequally, depressed by the bellies of the several muscles that rise from or act upon it; and, in old people, these muscles make distinct sinuosities for themselves. The external surface of the *fibula* is depressed obliquely from above downwards and backwards, by the two *peronæi*.—Its internal surface is unequally divided into two narrow longitudinal planes, by an oblique ridge extended from the upper part of the anterior angle, to join with the lower end of the internal angle. To this ridge the ligament stretched between the two bones of the leg is connected.—The anterior of the two planes is very narrow above, where the *extensor longus digitorum* and *extensor longus pollicis* arise from it; but is broader below, where it has the print of the *nonus Vesalii*.—The posterior plane is broad and hollow, giving origin to the larger share of the *tibialis posterior*.

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The

(*a*) Περικνημιον, perone, focile minus, arundo minor, canna minor cruris, fura, radius.

The internal angle of this bone has a tendinous membrane fixed to it, from which fibres of the *flexor digitorum longus* take their rise.—The posterior surface of the *fibula* is the plainest and smoothest; but is made flat above by the *soleus*, and is hollowed below by the *flexor pollicis longus*.—In the middle of this surface the canal for the medullary vessels may be seen slanting downwards.

I have taken particular notice of the entry and direction of the medullary vessels of the large bones of the extremities (a); because, in several surgical cases, a surgeon who is ignorant of this may do mischief to his patient. Thus, for example, if these vessels are opened very near to their entry into the bone, or while they are in the oblique passage through it, an obstinate hæmorrhagy may ensue: For the arteries being connected to the bony passage, styptics, and other like corrugators, are vainly applied; compressing instruments can do no service, and ligatures cannot be employed.—There seems to be a particular design in the contrivance of these canals; those in the *os humeri*, *tibia*, and *fibula*, running obliquely downwards from their external entry; whereas in the *radius*, *ulna*, and *os femoris*, they slant upwards, whereby the arteries and nerves which are sent into these three last bones must suffer a considerable reflection before they come at the *cancelli*. The reason of this diversity may perhaps be, that the arteries, which are so small within the bones as to have no strong contractile propelling force in their coats, and where they are not assisted by the action of any moving neighbouring organ, should have, at least in their passage through the bone, a favourable descent for their liquids: Which, it is evident, they have in the descending oblique passages formed for them in the first class of bones, to wit, the *os humeri*, *tibia*, and *fibula*, which are generally depending: And they also most frequently acquire the like advantage in the *radius*, *ulna*, and *os femoris*; because the hand, in the most natural posture, is higher than the elbow; and when we sit or lie, the lower end of the thigh-bone comes to be at least as high raised as the upper. In standing and walking, or when the arms are moved, the blood must indeed ascend as it passes through the bones of the forearm and thigh; but the pressure of the muscles, then in action, on the vessels, before they enter the bones, is sufficient to compensate the disadvantage

(a) Havers, Osteolog. Nov. disc. 1. p. 59.

vantage of their course. This reasoning seems to be still enforced, by observing, that this passage is always nearer the upper than the lower ends of these bones.

The lower end of the *fibula* is extended into a spongy oblong head, on the inside of which is a convex, irregular, and frequently a scabrous surface, that is received by the external hollow of the *tibia*, and so firmly joined to it by a very thin intermediate cartilage and strong ligaments, that it scarce can move.—Below this, the *fibula* is stretched out into a coronoid process, that is smooth, covered with cartilage on its internal side, and is there contiguous to the outside of the first bone of the foot, the *astragalus*, to secure the articulation. This process, named *malleolus externus*, being situated farther back than the internal *malleolus*, and in an oblique direction, obliges us naturally to turn the fore-part of the foot outwards (*a*). At the lower internal part of this process, a spongy cavity for mucilaginous glands may be remarked; from its point ligaments are extended to the *astragalus*, *os calcis*, and *os naviculare*, bones of the foot; and, from its inside, short strong ones go out to the *astragalus*. On the back-part of it, a sinuosity is made by the tendons of the *peronæi* muscles. —When the ligament extended over these tendons from the one side of the depression to the other is broke, stretched too much, or made weak by a sprain, the tendons frequently start forwards to the outside of the *fibula*.

The conjunction of the upper end of the *fibula* with the *tibia* is by plain surfaces tipped with cartilage; and, at its lower end, the cartilage seems to glue the two bones together, not, however, so firmly in young people, but that the motion at the other end of such a long *radius* is very observable.—In old subjects I often see the two bones of the leg grown together at their lower ends.

The principal use of this bone is to afford origin and insertion to muscles; the direction of which may be a little altered on proper occasions, by its upper part shuffling backwards and forwards.—It likewise helps to make the articulation of the foot more secure and firm.—The ends of the *tibia* and *fibula* being larger than their middle, a space is here left, which is filled up with such another ligament as I described, extended

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between

between the bones of the fore-arm ; and which is also discontinued at its upper part, where the *tibialis anticus* immediately adheres to the *solæus* and *tibialis posticus* ; but every where else it gives origin to muscular fibres (a).

Both the ends of this bone are cartilaginous in a ripe child, and assume the form of *appendices* before they are united to its body.

ROTULA (b) is the small flat bone situated at the fore-part of the joint of the knee.—Its shape resembles the common figure of the heart with its point downwards.—The anterior convex surface of the *rotula* is pierced by a great number of holes, into which fibres of the strong ligament that is spread over it enter.—Behind, its surface is smooth, covered with cartilage, and divided by a middle convex ridge into two cavities, of which the external is largest ; and both are exactly adapted to the pulley of the *os femoris*, on which they are placed in the most ordinary unstraining postures of the leg ; but when the leg is much bended, the *rotula* descends far down on the condyles ; and when the leg is fully extended, the *rotula* rises higher, in its upper part, than the pulley of the thigh-bone.—The plain smooth surface is surrounded by a rough prominent edge, to which the capsular ligament adheres :—Below, the point of the bone is scabrous, where the strong tendinous ligament from the tubercle of the *tibia* is fixed. The upper horizontal part of this bone is flatted and unequal, where the tendons of the extensors of the leg are inserted.

The substance of the *rotula* is cellular, with very thin external firm plates : But then these *cells* are so small, and such a quantity of bone is employed in their formation, that scarce any bone of its bulk is so strong. Besides, it is covered all over with a thick ligament, (as it was observed, that this sort of bones generally is), to connect its substance, and is moveable to one side or other ; therefore is sufficiently strong to resist the ordinary actions of the large muscles that are inserted into it, or any common external force applied to it ; while a fixed process, such as the *olecranon*, would not have been sufficient to bear the whole weight of our bodies, which frequently falls on it, and would have hindered the rotatory motion

(a) Weitbrecht, Syndesmolog. p. 156.

(b) Ἐπιμυλῖς, μυλακρίς, κογχῆς, ἐπιγονατὶς, πλανησιμεδρον, patella, mola, genu, scutiforme os, cartilaginofum, disciforme, oculus genu.

motion of the leg. Notwithstanding these precautions to preserve this bone from such injuries, yet I have seen a transverse fracture in it, when by the report of the patient, and of the people about him, and by the want of swelling, discolouring, or other mark of bruise or contusion, it was plain the bone was broken by the violent straining effort of the muscles (*a*). Though my patient recovered the use of the joint of the knee, yet I think it reasonable to believe, that this sort of fracture is commonly attended with difficulty of motion after the broken parts of the *rotula* are re-united; because the callous matter probably extends itself into the cavity of the joint, where it either grows to some of the parts, or makes such an inequality on the surface of this bone, as does not allow it to perform the necessary motions on the condyles of the *femur* (*b*).

At the ordinary time of birth, the *rotula* is entirely cartilaginous, and scarcely assumes a bony nature so soon as most *epiphyses* do.

The parts which constitute the joint of the knee being now described, let us examine what are its motions, and how performed.—The two principal motions are flexion and extension.—In the former of these, the leg may be brought to a very acute angle with the thigh, by the condyles of the thigh-bones being round and made smooth far backwards. In performing this, the *rotula* is pulled down by the *tibia*.—When the leg is to be extended, the *rotula* is drawn upwards, consequently the *tibia* forwards, by the extensor muscles: which, by means of the protuberant joint, and of this thick bone with its ligament, have in effect the chord with which they act fixed to the *tibia* at a considerable angle; therefore act with advantage: but are restrained from pulling the leg farther than to a straight line with the thigh, by the posterior part of the *cross* ligament, that the body might be supported by a firm perpendicular column; for at this time the thigh and leg are as little moveable in a rotatory way, or to either side, as if they were one continued bone.—But when the joint is a little bended, the *rotula* is not tightly braced, and the posterior ligament is relaxed: therefore this bone may be moved a little to either side, or with a small rotation in the superficial cavities of the *tibia*; which is done by the motion of the external cavity backwards and forwards, the

(*a*) See Ruysch, Observ. Anat. Chirurg. obs. 3.

(*b*) Parè, liv. 15. chap. 22.

the internal serving as a sort of axis (*a*). Seeing, then, one part of the *cross* ligament is situated perpendicularly, and the posterior part is stretched obliquely from the internal condyle of the thigh outwards, that posterior part of the *cross* ligament prevents the leg's being turned at all inwards; but it could not hinder it from turning outwards almost round, were not that motion confined by the lateral ligaments of this joint, which can yield little. This rotation of the leg outwards is of good advantage to us in crossing our legs, and turning our feet outwards, on several necessary occasions; though it is altogether fit this motion should not be very large, to prevent frequent luxations here.—While all these motions are performing, the part of the *tibia* that moves immediately on the condyles is only so much as is within the cartilaginous rings; which, by the thickness on their outsides, make the cavities of the *tibia* more horizontal, by raising their external side where the surface of the *tibia* slants downwards. By this means the motions of this joint are more equal and steady than otherwise they would have been. The cartilages, being capable of changing a little their situation, are fit for doing this good office in the different motions and postures of the member, and likewise contribute to make the motions larger and quicker.

On account of the very large surface of the bones forming the joint of the knee, and the many strong ligaments connecting them, luxations seldom happen here. But these very ligaments, the *aponeurosis* passing over this joint, the quantity of fat and mucilaginous glands necessary for lubricating it, make it more subject to *white swellings*, dropfies, and such other disorders, than any other joint of the body.

The *FOOT* is divided, as well as the hand, into three parts, viz. *tarsus*, *metatarsus*, and *toes*: In the description of which, the several surfaces shall be named, according to their natural situation, viz. the *broad* of the foot, shall be called superior; the *sole*, inferior; the side on which the great toe is, internal; that where the little toe is, external.

The *tarsus* (*a*) consists of seven spongy bones; to wit, the *astragalus*, *os calcis*, *naviculare*, *cuboides*, *cuneiforme externum*, *cuneiforme medium*, and *cuneiforme internum*.

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(*a*) Winslow, Exposition Anatomique du Corps Humain, traité des Os secs, § 976.

(*b*) Raffetta.

The *astragalus* is the uppermost of these bones.—The *os calcis* is below the *astragalus*; and is considerably prominent backwards beyond the other bones, to form the heel.—The *os naviculare* is in the middle of the internal side of the *tarsus*.—The *os cuboides* is the most external of the row of four bones at its fore-part.—The *os cuneiforme externum* is placed at the inside of the *cuboid*; the *cuneiforme medium* is between the *external* and *internal cuneiform* bones; and the *internal cuneiform* is put at the internal side of the foot.

That the description of these bones may not be immoderately swelled with repetition, I desire, once for all, to observe, That wherever a ridge is mentioned, without a particular use assigned, a ligament is understood to be fixed to it; or where a spongy rough cavity, depression, or *fossa*, is remarked, without naming its use, a ligament is inserted, and mucilaginous glands are lodged: for such will occur in the detail of each of these bones.

The upper part of the *astragalus* (*a*) is formed into a large smooth head (*b*), which is slightly hollowed in the middle; and therefore resembles a superficial pulley, by which it is fitted to the lower end of the *tibia*.—The internal side of this head is flat and smooth, to play on the internal *malleolus*.—The external side has also such a surface, but larger, for its articulation with the external *malleolus*.—Round the base of this head there is a rough *fossa*; and, immediately before the head, as also below its internal smooth surface, we find a considerable rough cavity.

The lower surface of the *astragalus* is divided by an irregular deep rough *fossa*; which at its internal end is narrow, but gradually widens as it stretches obliquely outwards and forwards.—The smooth surface, covered with cartilage, behind this *fossa*, is large, oblong, extended in the same oblique situation with the *fossa*, and concave for its conjunction with the *os calcis*.—The back-part of the edge of this cavity is produced into two sharp-pointed rough processes; between which is a depression made by the tendon of the *flexor pollicis longus*.—The lower surface before the *fossa* is convex, and composed of three distinct smooth planes. The long one behind, and the exterior or shortest, are articulated with the heel-

(a) *Αστράγαλος* talus, balistæ os, malleolus, chaib, quatrio, os tessare, claviculæ, nuciforme..

(b) *Τίτλαρος*.

heel-bone; while the internal, which is the most convex of the three, rests and moves upon a cartilaginous ligament, that is continued from the *calcaneum* to the *os scaphoides*. Without which ligament, the *astragalus* could not be sustained, but would be pressed out of its place by the great weight it supports, and the other bones of the *tarsus* would be separated. Nor would a bone be fit here, because it must have been thicker than could conveniently be allowed; otherwise it would break, and would not prove such an easy bending base, to lessen the shock which is given to the body in leaping, running, &c.

The fore-part of this bone is formed into a convex oblong smooth head, called by some its process, which is received by the *os naviculare*. Round the root of this head, especially on the upper surface, a rough *fossa* may be remarked.

The *astragalus* is articulated above to the *tibia* and *fibula*; which together form one cavity. Though, in this articulation, the bones have prominencies and cavities so small, as might allow motions in all directions; yet the flexion and extension are the most considerable, the other motions being confined by the *malleoli*, and by the strong ligaments which go out from the points of these processes to the *astragalus* and *os calcis*.—When the foot is bended, so far as it is commonly when we stand, no lateral or rotatory motion is allowed in this joint; for then the head of the *astragalus* is sunk deep between the *malleoli*, and the ligaments are tense: but when the foot is extended, the *astragalus* can move a little to either side, and with a small rotation. By this contrivance, the foot is firm, when the weight of the body is to be supported on it; and when a foot is raised, we are at liberty to direct it more exactly to the place we intend next to step upon.—The *astragalus* is joined below to the *os calcis*, and before to the *os naviculare*, in the manner to be explained when these bones are described.

A considerable share of this bone is ossified in a new-born infant.

Calcaneum (a) is the largest bone of the seven.—Behind, it is formed into a large knob, commonly called the *heel*: the surface of which is rough behind, where the *tendo Achillis* is inserted into it; and above, it is hollow and spongy: Farther forwards, on the upper surface of the
calcaneum,

(a) *Os calcis*, *πτερυγα*, *calcar pedis*.

calcaneum, there is an irregular oblong smooth convexity, adapted to the concavity at the back-part of the *astragalus*; and beyond this a narrow *fossa* is seen, which divides it from two small concave smooth surfaces, that are joined to the fore-part of the *astragalus*.—Behind the posterior of these smooth surfaces, which is the largest, a small sinuosity is made by the tendon of the *flexor digitorum longus*; at the fore-part of which a small rough protuberance appears, that gives rise to the *musculus extensor digitorum brevis*.

The external side of this bone is flat, with a superficial *fossa* running horizontally, in which the tendon of the *musculus peronæus longus* is lodged.—The internal side of the heel-bone is hollowed, for lodging the origin of the *massa cornea Jac. Sylvii*, and for the safe passage of tendons, nerves, and arteries.—Under the side of the internal smooth concavity, a particular groove is made by the tendon of the *flexor pollicis longus*; and from the thin protuberance on this internal side, the cartilaginous ligament that supports the *astragalus*, goes out to the *os naviculare*; on which ligament, and on the edge of this bone to which it is fixed, the groove is formed for the tendon of the *flexor digitorum profundus*.

The lower surface of this bone is pressed flat at the back-part, by the weight of our bodies; and immediately before this plane there are two tubercles, from the internal of which the *musculus abductor pollicis*, *flexor digitorum sublimis*, as also part of the *aponeurosis plantaris*, and of the *abductor minimi digiti*, have their origin; and the other part of the *abductor minimi digiti* and *aponeurosis plantaris* rises from the external.—Before these protuberances this bone is concave, for lodging the flexor muscles: and at its fore-part we may observe a rough depression; from which, and a tubercle behind it, the ligament goes out that prevents this bone to be separated from the *os cuboides*.

The fore-part of the *os calcis* is formed into an oblong pulley-like smooth surface, which is circular at its upper external end, but is pointed below. This smooth surface is fitted to the *os cuboides*.

Though the surfaces by which the *astragalus* and *os calcis* are articulated, seem fit enough for motion; yet the very strong ligaments by which these bones are connected, prevent it, and render this principal part of our base, which rests on the ground, to wit, the *os calcis*, firm.

A large share of the heel-bone is ossified at the ordinary time of birth ; and the large knob appears afterwards in form of an *epiphyse*.

Os naviculare (a) is somewhat circular.—It is formed into an oblong concavity behind, for receiving the anterior head of the *astragalus*.—On the upper surface there is a rough *fossa*.—Below, the *os naviculare* is very unequal and rough ; but hollow, for the safety of the muscles.—On its inside a large knob rises out, from which the *abductor pollicis* takes in part its origin, the tendon of the *tibialis posticus* is inserted into it, and to it two remarkable ligaments are fixed : the first is the strong one, formerly mentioned, which supports the *astragalus* ; the second is stretched from this bone obliquely cross the foot, to the metatarsal bones of the middle toe, and of the toe next to the little one.—On the outside of the *os naviculare* there is a semicircular smooth surface, where it is joined to the *os cuboides*.—The fore-part of this bone is all covered with cartilage, and is divided into three smooth planes, fitted to the three *ossa cuneiformia*.

The *os naviculare* and *astragalus* are joined as a ball and socket ; and the *naviculare* moves in all directions in turning the toes inwards, or in raising or depressing either side of the foot, though the motions are greatly restrained by the ligaments which connect this to the other bones of the *tarfus*.—A weakness of these ligaments causes sometimes an unnatural turn of the fore-part of the foot inwards.

The *os naviculare* is wholly cartilaginous in a new-born infant.

OS CUBOIDES (a) is a very irregular cube.—Behind, it is formed into an oblong unequal concavity, adapted to the fore-part of the *os calcis*.—On its internal side, there is a small semicircular smooth cavity, to join the *os naviculare*.—Immediately before which, an oblong smooth plane is made by the *os cuneiforme externum*.—Below this, the bone is hollow and rough. On the internal side of the lower surface, a round protuberance and *fossa* are found, where the *musculus adductor pollicis* has its origin. On the external side of this same surface, there is a round knob covered with cartilage ; immediately before which, a smooth *fossa* may be observed, in which the tendon of the *peronæus primus* runs obliquely cross the foot ; and on the knob, the thin flat cartilage proper to this muscle plays ; in place

(a) Σκαροειδης, *os cymbæ*.

(b) Πολυμορφον, *cubiforme, quadratum, grandinosum, varium, tessaræ, multiforme*.

place of which sometimes a bone is found.—More externally than the knob, a rough hollow is made, for the strong ligaments stretched betwixt this bone and the *os calcis*.—Before, the surface of the *os cuboides* is flat, smooth, and slightly divided into two planes, for sustaining the *os metatarsi* of the little toe, and of the toe next to it.

The form of the back-part of the *os cuboides*, and the ligaments connecting the joint there with the *os calcis*, both concur in allowing little motion in this part.

The ossification of this bone is scarcely begun at the birth.

Os cuneiforme externum (a), if we regard its situation or *medium* by its bulk, is much of the shape of a wedge, being broad and flat above, with long sides running obliquely downwards, and terminating in a sharp edge.—The upper surface of this bone is an oblong square.—The one behind is nearly a triangle, but not complete at the inferior angle, and is joined to the *os naviculare*.—The external side is an oblong square, divided as it were by a diagonal: the upper half of it is smooth, for its conjunction with the *os cuboides*: the other is a scabrous hollow, and in its superior anterior angle a small smooth impression is made by the *os metatarsi* of the toe next to the little one.—The internal side of this bone is also quadrangular, with the fore-part of its edge made flat and smooth by the *os metatarsi* of the toe next to the great one; and the back-part is also flat and smooth where the *os cuneiforme medium* is contiguous to it.—The fore-part of this bone is an oblong triangle, for sustaining the *os metatarsi* of the middle toe.

Os cuneiforme medium, or *minimum*, is still more exactly the shape of a wedge than the former.—Its upper part is square:—its internal side has a flat smooth surface above and behind, for its conjunction with the following bone, with a small rough *fossa* below; and a considerable share of it is rough and hollow.—The external side is smooth, and a little hollowed, where it is contiguous to the last described bone.—Behind, this bone is triangular, where it is articulated with the *os naviculare*; and it is also triangular at its fore-part, where it is contiguous to the *os metatarsi* of the toe next to the great one.

Os cuneiforme maximum, or *internum*, differs from the two former in its

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situation.

(a) Chalcoideum externum.

situation. which is more oblique than theirs.—Besides, its broad thick part is placed below, and the small thin point is above and outwards; while its under broad surface is concave, for allowing a safe passage to the flexors of the great toe.—The surface of this *os cuneiforme* behind, where it is joined to the *os naviculare*, is hollow, smooth, and of a circular figure below, but pointed above.—The external side consists of two smooth and flat surfaces, whose direction is nearly at right angles with each other. With the posterior, that runs obliquely from below forwards and upwards, the *os cuneiforme minimum* is joined; and with the anterior, whose direction is longitudinal, the *os metatarsi* of the toe next to the great one is connected.—The fore-part of this bone is semilunar, but flat and smooth, for sustaining the *os metatarsi* of the great toe.—The internal side is scabrous, with two remarkable tubercles below, from which the *musculus abductor pollicis* rises; and the *tibialis anticus* is inserted into its upper part.

The three cuneiform bones are all so secured by ligaments, that very little motion is allowed in any of them; and they are cartilaginous in a *fœtus* of nine months.

These seven bones of the *tarsus*, when joined, are convex above; and leave a concavity below, for lodging safely the several muscles, tendons, vessels, and nerves, that lie in the sole of the foot.—In the recent subject, their upper and lower surfaces are covered with strong ligaments, which adhere firmly to them: and all the bones are so tightly connected by these and the other ligaments, which are fixed to the rough ridges and *fossæ*, mentioned in the preceding description of the particular bones, that, notwithstanding the many surfaces covered with cartilage, some of which are of the form of the very moveable articulations, no more motion is here allowed, than only to prevent too great a shock of the fabric of the body in walking, leaping, &c. b, falling on too solid a base; which, if it was one continued bone, would likewise be much more liable to be broken; and in order to make our foot accommodate itself to the surfaces we tread on, by becoming more or less hollow, or by raising or depressing either side of it, as might be judged by what was said of the particular bones.

Sprains

Sprains here occasion, as in the wrist, great pain and obstinate tumours, which too often cause carious bones.

METATARSUS (*a*) is composed of five bones, which, in their general characters, agree with the metacarpal bones; but may be distinguished from them by the following marks: 1. They are longer, thicker, and stronger. 2. Their anterior round ends are not so broad, and are less in proportion to their bases. 3. Their bodies are sharper above and flatter on their sides, with their inferior ridge inclined more to the outside. 4. The tubercles at the lower parts of the round head are larger.

The first or internal metatarsal bone is easily distinguished from the rest by its thickness.—The one next to it is the longest, and with its sharp edge almost perpendicular.—The others are shorter and more oblique, as their situation is more external. Which general remarks, with the description I am now to give of each, may teach us to distinguish them from each other.

Os metatarsi pollicis is by far the thickest and strongest, as having much the greatest weight to sustain. Its base is oblong, irregularly concave, and of a semilunar figure, to be adapted to the *os cuneiforme maximum*.—The inferior edge of this base is a little prominent and rough, where the tendon of the *peroneus primus* muscle is inserted.—On its outside an oblique circular depression is made by the second metatarsal bone.—Its round head has generally on its fore-part a middle ridge, and two oblong cavities, for the *ossa sesamoidea*; and on the external side a depression is made by the following bone.

Os metatarsi of the second toe, is the longest of the five, with a triangular base supported by the *os cuneiforme medium*, and the external side produced into a process; the end of which is an oblique smooth plane, joined to the *os cuneiforme externum*.—Near the internal edge of the base, this bone has two small depressions made by the *os cuneiforme maximum*, between which is a rough cavity.—Farther forwards we may observe a smooth protuberance, which is joined to the foregoing bone.—On the outside of the base are two oblong smooth surfaces, for its articulation with the following bone; the superior smooth surface being extended
longi-

(*a*) Στῆθος, πῆδον, planta, planum, vestigium, folium, pectus, præcordium, pectusculum.

longitudinally, and the inferior perpendicularly; between which there is a rough *fossa*.

Os metatarsi of the middle toe, is the second in length.—Its base, supported by the *os cuneiforme externum*, is triangular, but slanting outwards, where it ends in a sharp-pointed little process; and the angle below is not completed.

The internal side of this base is adapted to the preceding bone; and the external side has also two smooth surfaces covered with cartilage, but of a different figure; for the upper one is concave, and, being round behind, turns smaller as it advances forwards; and the lower surface is little, smooth, convex, and very near the edge of the base.

Os metatarsi of the fourth toe, is near as long as the former, with a triangular slanting base joined to the *os cuboides*, and made round at its external angle, having one hollow smooth surface on the outside, where it is pressed upon by the following bone, and two on the internal side, corresponding to the former bone; behind which is a long narrow surface impressed by the *os cuneiforme externum*.

Os metatarsi of the little toe, is the shortest, situated with its two flat sides above and below, and with the ridges laterally.—The base of it, part of which rests on the *os cuboides*, is very large, tuberos, and produced into a long pointed process externally, where part of the *abductor minimi digiti* is fixed; and into its upper part the *peronæus secundus* is inserted.—Its inside has a flat conoidal surface, where it is contiguous to the preceding bone.

When we stand, the fore-ends of these metatarsal bones, and the *os calcis*, are our only supporters; and therefore it is necessary they should be strong, and should have a confined motion.

The bones of the TOES are much a-kin to those of the thumb and fingers; particularly the two of the great toe are precisely formed as the two last of the thumb: only their position, in respect of the other toes, is not oblique; and they are proportionally much stronger, because they are subjected to a greater force; for they sustain the force with which our bodies are pushed forwards by the foot behind at every step we make, and on them principally the weight of the body is supported when we are raised on our tiptoes.

The three bones in each of the other four toes, compared to those of the fingers, differ from them in these particulars.—They are less, and smaller in proportion to their lengths:—Their bases are much larger than their anterior ends: Their bodies are more narrow above and below, and flatter on the sides.—The first *phalanx* is proportionally much longer than the bones of the second and third, which are very short.

Of the four, the toe next to the great one, has the largest bones in all dimensions, and more externally the toes are less. The little toe, and frequently that next to it, have the second and third bones intimately united into one; which may be owing to their little motion, and the great pressure they are subjected to.

The toes are of good use to us in walking; for, when the sole is raised, they bring our body, with its centre of gravity, perpendicular to the advanced foot.

The bones of the *metatarsus* and toes, are in the same condition in children as those of the *metacarpus* and fingers.

The only bones now remaining to complete the description of the skeleton, are the small ones, which are found at the joints of the fingers and toes, and in some other parts, called

OSSA SESAMOIDEA, which are of very different figures and sizes though they are generally said to resemble the seed of the *sesamum*.—They seem to me nothing else than the ligaments of the articulations or the firm tendons of strong muscles, or both, become bony, by the compression which they suffer. Thus the *sesamoid* bones at the beginning of the *gastrocnemii* muscles, are evidently composed of the tendinous fibres only.—These, at the first joint of the great toe, are as plainly the same continued substance with the ligaments and the tendons of the *adductor*, *flexor*, *brevis*, and *abductor*.—That which is sometimes double at the second joint of that toe, is part of the capsular ligament; and if we may enumerate the other *sesamoid* bones that are at any time found, we observe all of them formed in this manner.—Their number, figure, situation, and magnitude, are so uncertain, that it were in vain to insist on the differences of each; and therefore I shall only in general remark,

1. That wherever the tendons and ligaments are firmest, the actions
of

of the muscles strongest, and the compression greatest, there such bones are most commonly found.

2. That, *cæteris paribus*, the older the subject is in which they are fought, their number is greater, and their size is larger.

3. The more labour any person is inured to, he has, *cæteris paribus*, the most numerous and largest *ossa sesamoidea*.

However, as the two at the first joint of the great toe are much larger than any other, are early formed, and are seldom wanting in an adult, we may judge, that, besides the more forcible cause of their formation, there should also be some particular advantage necessary at this place, rather than elsewhere, which may possibly be, to allow the *flexor* muscles to send their tendons along this joint, secure from compression in the hollow between the two oblong sesamoid bones; while, by removing these tendons from the centre of motion, and giving them the advantage of an angle at their insertion, the force of the muscles is increased, and therefore the great superincumbent weight of our body in progression is more easily raised.

A P P E N D I X.

Of the MARKS of a FEMALE SKELETON.

TO finish the description of the bones, is generally to conclude the *osteology*: but, that no part of the subject may be left untouched, I think it necessary to subjoin the distinguishing marks of the male and female skeletons; and have chosen to illustrate them principally in the latter; because women having a more delicate constitution, and affording lodging and nourishment to their tender *fætuses* till they have sufficient strength and firmness to bear the injuries of the atmosphere and contact of other more solid substances, their bones are frequently incomplete, and always of a make in some parts of the body different from those of the robust male; which agree to the description already given, unless where the proper specialities of the female were particularly remarked; which could not be done in all places where they occur, without perplexing the order of this treatise: Therefore I chose rather to sum them up here by way of *appendix*.

The causes of the following specialities of the female bones may be reduced to these three: 1. A weak lax constitution. 2. A sedentary unactive life, increasing that constitution. 3. A proper frame for being mothers.

The bones of women are smaller in proportion to their length than those of men; because the force of their muscles is not so great, nor is such strong external force applied to them to prevent their stretching out in length.

The depressions, ridges, scabrous surfaces, and other inequalities made by the muscles, are not so conspicuous in them; because their muscles are neither so thick nor strong, nor so much employed, to make so strong prints on their bones.

Their *os frontis* is more frequently divided by a continuation of the

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sagittal future, which depends on the first and second general causes assigned above for the specialities in their bones, as will appear after reflecting on the account given formerly of the middle internal spine of this bone.

Their *clavicles* are less crooked ; because their arms have been less forcibly pulled forwards, which, in our *European* women, especially those of distinction, is more hindered by their garb.

Their *sternum* is more raised by long cartilages below, that the *thorax* might be there widened in some proportion to what it is shortened by the pressure upon the *diaphragm* when they are with child.

The defect of bone, or the hole in the middle of the *sternum*, is ofteneft found in them ; to allow the passage of the mammary vessels, say some. But, in my opinion, this is owing to a lax constitution, by which the ossification is not so soon completed as in men, where the action of the solids is vigorous, and the circulation of the fluids is brisk : for a much smaller hole might have served this purpose ; and the branches of the internal mammary vessels which are sent to the external parts of the *thorax*, do not pass here, but between the cartilages of the ribs, before these are joined to the *sternum*.

The *cartilago xiphoides*, is oftener bifurcated in women than in men, for the reason assigned in the preceding paragraph, viz. a less forcible power of ossification.

The superior cartilages of the ribs sooner ossify, to support the weight of the *mammæ*.

The middle cartilages are more flat and broad by the weight of the breasts.

The inferior cartilages are longer, for enlarging the chest.

Weak women, who have born many children when young, often have the *vertebræ* of their back bended forwards, and their *sternum* depressed, or become round-shouldered and flat-breasted (*a*) by the pressure and weight of the impregnated *uterus*, and by the strong action of the abdominal muscles.

The *os sacrum* is broader, and turned much more backwards, for enlarging the *pelvis*.

The

(a) Cheselden's Anatomy, book 1. chap. 3.

The *os coccygis* is more moveable, and much less bended forwards, to facilitate the birth.

The *ossa ilium* are more hollow, and more reflected outwards, and consequently further removed from each other, in order to widen the lower part of the *abdomen*, and for the better support of the impregnated *uterus*.

The ridge on the upper part of the *os pubis* is larger in such women as have born children, being extended by the strong action of the *musculi recti abdominis*.

The cartilage between the two *ossa pubis*, especially in women who have born children, is thicker than in men, by which the *pelvis* is more capacious in females.

The conjoined surfaces of the *ossa pubis*, and of the *ossa innominata* and *sacrum*, are less; the angle under the *symphysis* of the *ossa pubis* is much larger; and the arches formed below and behind by the *ossa ilium* and *ischium* are wider; which, with the straighter *os sacrum*, and more distant *tubera ischii*, leave a larger passage for the exclusion of the child in birth.

The great tuberosity of the *ossa ischium*, is flatter in women than in men, because it is more pressed upon in the sedentary life which females enjoy.

In consequence of the *pelvis* of women being wider, the articulations of their thigh-bones must be farther removed from each other; and therefore a larger space is left for the procreation and birth of children (a): which distance of the thighs, may be one reason why women in running generally shuffle more from one side to the other than men, to preserve the centre of gravity of their bodies from falling too far to a side of the joint of the thigh that supports them when the other is raised, which would endanger their tumbling to the ground.

(a) Albin. de Orib. § 339.

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D E S C R I P T I O N

O F A

SKULL uncommon for the Number and Size of the OSSA TRIQUETRA.

IT is my business, in teaching, to show the young gentlemen, my pupils, not only the structure which generally obtains, but likewise as many of the useful *usus naturæ* as I can. By useful, I mean all such as can assist them in explaining the animal-œconomy and diseases, or can prevent their committing mistakes in practice. Among these deviations from the ordinary structure, I reckon the *ossa triquetra*, which are sometimes seen in the several sutures of the cranium, but more frequently in the lambdoid than in any other; for, without being acquainted with them, one may judge a slight wound of a person who had such bones, to be a violent fracture of the skull.

Among the different skulls in my possession, there is one which has these bones more remarkable than any I have seen.

Fig. 3. of Plate I. represents the posterior view of the cranium, where the several pricked lines from AA terminate in *ossa triquetra*, placed in the upper part of the lambdoid suture. BB are the holes of the parietal bones, much larger than in most skulls.

On the same Plate,

Fig. 4. is the vomer of a young child, in nearly the natural situation; *a* is the lower part, which rests on the palate-plates of the palate and maxillary bones; *b* the posterior edge between the back-part of the palate

late and the base of the skull; *c* the wide hollow for receiving the thick spongy *processus azygos* of the *os sphenoides*; *d*, *e*, the serrated superior edges receiving the cartilaginous *nasal plate* of the *os ethmoides*: From *e*, to the point *f*, this plate is cartilaginous even in adults.

Fig. 5. is another view of the same vomer, where the same letters point to the same things; only the inferior side *a* is put uppermost, and brought in view to show the little rising in its middle *z*, which enters between the palate-plates, while the sides are depressed.

REMARKS

Nº 5.

R E M A R K S

O N T H E

Articulation, Muscles, and Luxation, of the LOWER JAW.

IT is now near two centuries since anatomists have been universally acquainted with all the principal parts belonging to the lower jaw : They have known, that the condyles are covered with a smooth cartilage ; that the jaw moves on these processes, which are received into a cavity of each temporal bone, immediately behind the root of the zygomatic process : And some have said, that the condyle of each side moves on the root of the zygoma. Nor have they been ignorant of the oblong moveable cartilage, which is concave in the middle on both sides, and is interposed between each condyle and the temporal bone with which it is articulated, nor of the ligament that connects the parts of this articulation. They have likewise described eight muscles that serve to raise the lower jaw, and all the other muscles which are so fixed to this bone as to be capable of pulling it down.

Though this account seems to comprehend all the parts that deserve to enter into a description ; yet I imagine the mechanism of these parts is not hitherto sufficiently explained, authors having either overlooked some necessary circumstances of the structure, or observing too negligently the actions and motions performed here, and mistaking the proper organs of them : I therefore submit to your judgments to determine, whether the following remarks on the articulation and motion of the condyles, and on the actions of some of the muscles of the lower jaw, with a short observation

tion or two on the luxation of that bone, and the manner of reducing it, deserve a place in your Collection *.

Each condyle of the lower jaw is not articulated only with the cavity behind the zygoma, or only with the root of that process; but both the anterior part of the cavity, and the posterior part of the tubercle at the root of the zygoma, are covered with smooth cartilage for the jaw to move on; and the ligament of this joint is fixed into the circumference of these two surfaces. The share of the cavity covered with cartilage is small, but the ligament generally is spread over, and loosely connected by cellular membranes to a larger share of it backwards; and the large part, which still remains behind this, is filled externally with the parotid gland, which I have seen frequently resemble, at this place, the glands commonly called *conglobate*, in its firmness and smoothness; but never could separate this part from the rest of the gland without violence. In the remaining share of the cavity, immediately before the styloid process, a fat cellular substance is lodged.

The exterior extremity of this oblong posterior cavity is made very narrow by the *meatus auditorius externus* being considerably advanced forwards here; which again prevents the condyle ever to be pushed so far back, as to be in hazard of doing any injury to the gland situated in the more internal part of the cavity.

The ligament which rises from the circumference of the smooth surface of the temporal bone, is considerably long and wide, and is inserted into the edge of the concave moveable cartilage; from which edge another ligament goes out to surround the condyle of the jaw, and to be inserted into the neck of that bone. This last ligament is more tightly connected to the cartilage and bone than the former.

Each condyle of the jaw-bone stands with its greatest length transversely, but with a small degree of obliquity, the external extremity being a little farther advanced forwards than the other. It is also worth while to observe, that the convexity of this process is not perpendicular to the neck of the bone, but is almost turned entirely forwards, where it is covered with cartilage for the articulation; while the neck and posterior surface

* The Edinburgh Medical Essays; where this Paper was originally inserted.

surface of the condyle appear in one straight flat surface, with very little cartilage covering the upper part of it.

Into the anterior edge of the moveable cartilage interposed between each condyle and temporal bone, a considerable share of the external pterygoid muscle is strongly inserted, and some few fibres of the temporal and masseter muscles are also fixed to the external and superior part of this cartilage. Dr Douglas (*a*) is the only author I know who has so much as hinted this insertion of these muscles.

For better understanding the preceding descriptions, the parts described, in their natural situation and magnitude, are represented on Plate II. fig. 1.

When the teeth of both jaws are opposite, each to those of the same class, the condyles of the lower jaw are, in most men, placed in the cavity of each temporal bone; but as soon as the teeth of the lower jaw are advanced forward beyond the range of the superior, the condyles descend on the tubercles. This any one can be sensible of in himself, by laying his fingers on the angles of his own jaw while he performs these motions; and it is obvious to the sight when the articulation is laid bare by dissection, and the bone is moved in the manner mentioned.

The condyles can be moved laterally when they are lodged in the cavities or on the tubercles; but these lateral motions are much more confined in the cavities, because of the surrounding brims. These facts are to be examined in the same way as the former.

The lateral motions, and those backwards and forwards, of the lower jaw, being exceedingly necessary for us in chewing, this mechanism of a double sort of articulation in a cavity, and on a protuberance, answers the design much more effectually than any one uniform surface could have done, whether we suppose it plain, convex, or concave; for in any of these, the motion neither could have been so gradual nor so steady, and at the same time so free and large. But without the interposition of a double concave cartilage, the motion of the condyle on the tubercle would have been vacillating, and often dangerous, seeing the two convexities could only touch each other in one straight line; and therefore the condyle would have slid off, either back to the cavity again, or for-

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(*a*) Myograph. chap. 20. and Append. p. 8.

ward to occasion a luxation : whereas the cartilage, when placed on the tubercle, renders the surface on which the condyle is to rest really concave, and exactly fitted to the convexity of that process. If, however, this cartilage were to remain always in the same situation in respect of the condyle, it would be unnecessary, if not inconvenient, when this process is lodged in the cavity : therefore the cartilage is never pressed farther back than the posterior surface of the tubercle, and there it receives the anterior convex surface of the condyle : but while the cartilage is on the lower part of the tubercle, only the superior straight part of the condyle is joined to it. This is evident on performing these motions, after the joint is laid bare, and part of the ligament which goes between the condyle and the moveable cartilage is cut.

The surface of both condyle and cartilage is so slippery, the anterior edge of the cartilage is so little prominent, and the anterior part of the ligament connecting the two is so loose, that the pressure of the condyle on the cartilage would not be sufficient to bring the cartilage as quickly forward as the condyle ; which, however, I have endeavoured to prove is necessary : to prevent, therefore, the inconveniencies that might arise from the condyle's being immediately contiguous to the tubercle, some of the muscles which serve to move the condyle forwards are also inserted into the cartilage, and will equally advance both ; and as the *external pterygoid* muscle has the most direct action this way, and indeed the largest share in performing this motion, it has the greatest number of fibres inserted into the edge of the cartilage.

If the mouth were opened while the condyle stands on the tubercle, the flat back-part of the condyle would be applied to the cartilage ; the anterior prominence of which would consequently have little effect in preventing the condyle to slip forward : So that, if the least force was employed at the same time to pull or push the jaw forward, a dislocation would inevitably happen. To prevent which, the muscles that open the mouth are so situated, that when they act, they must also pull the jaw backward : Hence when one attempts to open his mouth, while the under teeth are advanced beyond the upper, he immediately is sensible of the jaw's sliding back ; and no dislocation does happen, without an external force applied, unless when the raisers of the jaw, by a convulsive contraction,

traction, as in yawning or violent vomiting, do forcibly keep the jaw forwards, in the time that the depressoers are acting.

All the forces said to be employed to bring the lower jaw down in opening of the mouth, are the weight of the jaw itself, the action of the *platysma myoides*, and of the digastric muscles; but as the two first are commonly allowed to be of little account, authors generally mention the digastric muscles to be the sole antagonists to the eight muscles that raise the jaw: which I have long suspected to have been assumed without sufficient examination, there being some obvious appearances that would seem to infer an incapacity in these digastric muscles, to open the mouth so wide, and with such force, as we really see it is; such as,

1. The fleshy bellies of the digastric muscles would appear too short for performing such a large contraction as is often required, whether we allow, according to the common way of reckoning, each fleshy fibre to contract one third of its length; and still less, if, with Bernouilli (*a*), we restrict such contraction to one third of the length of the fibre.

2. The proportional force of the digastrics to that of the levators of the jaw, is considerably less than what is commonly observed in other parts of the body, where antagonist muscles are; which proportional force of these muscles is, on some occasions, greatly lessened by the angle of insertion of these digastric muscles into the jaw, decreasing as the mouth is opened.

These suspicions made me to inquire more exactly into the structure of the parts; and to try some experiments, which seem all to contradict the common opinion. For,

3. There is no pulley the least a-kin to that of the larger oblique muscle of the eye, through which the tendon of each digastric muscle passes: but what is commonly called the ligament connecting the tendon of the digastrics to the *os hyoides*, is nothing else than part of the proper tendinous fibres of the digastric muscle, sent off from the rest in form of an aponeurosis (*b*), which is fastened to the *os hyoides*, and is in part spread over the inferior extremity of the mylo-hyoideus muscle, to be united to such another aponeurosis of the other side; and the connexion of this aponeurosis, as it comes off from the round tendon, is so firm,

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that

(*a*) Act. Petropolit. tom. i.

(*b*) See Cowper's Myot. Tab. xxiii.

that the least shuffling or motion of the round tendon within this ligamentous sheath, as it is commonly called, is not allowed: But this aponeurosis being of some length, it can yield a little backward or forward, when one or t'other of the fleshy bellies of the digastric muscle is shortened. Since, then, there is no sheath in which the middle tendon can slide, but that, on the contrary, it is connected to the *os hyoides*, we may see the unfitness of the posterior heads of the two digastric muscles for pulling the jaw down.

4. That we may have ocular conviction of the posterior belly of the digastric having no effect on the lower jaw, let it be laid bare in a dead body, whose head must be reclined back for this purpose, and then pull this muscle in the direction of its fibres, while the *os hyoides* is kept firm, or a little brought down, (which this bone evidently is when the mouth is opened), the jaw will not in the least be moved. If the *os hyoides* is left unfixed while the muscle is pulled, that bone is brought upwards, till the two heads of the digastric are brought to form a straight line; after which, indeed, the force applied to the posterior belly of the muscle begins to depress the jaw. But as the first case of the *os hyoides* being kept firm, is the only supposition to be allowed in the present question, I presume this conclusion, from the foregoing observations, will scarce be refused: That the common account of the action of the digastric muscles is not altogether so unexceptionable as it has hitherto passed for.

Having undone the mechanism of a pulley, through which the middle tendon of each digastric is said to pass; and having excluded the posterior head of that muscle from its office of pulling the jaw-bone down; I am almost induced to think, that, in the ordinary depressions of the lower-jaw, the anterior bellies of the digastric muscles are as little employed as the posterior. For,

5. When the two extremities of this anterior head are pulled towards the middle, by the help of a thread passed through the firm tendinous part near each extremity, the ends of which are crossed, and equally drawn in the direction of the fibres, which is the fairest way of knowing the action of any muscle, both whose extremities are moveable; when, I say, the anterior head of the digastric muscle is pulled in this manner, we observe the tendinous aponeurosis yield near as much forwards as one
would

would expect the natural contraction of this fleshy belly would require. When the aponeurosis is fully stretched, the *os hyoides* is brought upwards, and then the jaw-bone is pulled down. If the *os hyoides* is kept firm, while this muscle is thus drawn, its effects on the lower jaw will be greater and more observable: and if the posterior head is also pulled at the same time, the whole effort of the force wherewith the anterior belly is drawn, is employed in opening the mouth. From which it would appear, that, in order to apply the power of this anterior muscular head to the jaw-bone, it is necessary to suppose the posterior belly to act at the same time with it, that the aponeurosis may be kept stretched; which is all the service this posterior head does: and in performing this, it must exert a force equal to the contraction of the anterior belly; and that force must be employed in the direction of its muscular fibres on the *os hyoides*, and therefore must counteract the muscles which pull the *os hyoides* down: but I shall afterwards prove, that the action of these last muscles is constant and necessary in opening of the mouth; consequently the jaw gains nothing on this supposition of the anterior belly of the digastric assisting the depression of it, since an equal power is lost by the action of the posterior head. From all which there is at least a seeming improbability of any part of the digastric muscle acting in the depression of the jaw, when nothing is to be gained by it.

6. To confirm what has been argued for in the preceding paragraph, let any one whose *tunica cellulosa* is not too well filled, apply his fingers to the teguments that cover the anterior heads of the digastric muscles, while the mouth is opened ever so wide, quickly, or strongly, he will indeed feel these muscles protruded a little outwards, by the swelling of those above them; but will not be sensible of their becoming either harder or shorter; which, however, is plainly to be felt at this same time in much thinner muscles, the sterno-hyoidei and sterno-thyroidei, by placing another finger on the fore-part of the *trachea arteria*; and is manifest in these same anterior heads of the digastrics, when deglutition is performed.

The office I would assign to the digastric muscles is to be principal instruments in the compound action of deglutition; one part of which they are exceedingly well adapted to perform, which is to pull the *os hyoides* upwards,

upwards, and thereby to press the root of the tongue, &c. to the *velum pendulum palati*; for which purpose, the only organs commonly mentioned, the *stylo-hyoidei*, *stylo-glossi*, and perhaps the *stylo-pharyngei*, muscles are too weak, considering the resistance they must meet with in raising so many parts, viz. the tongue, *os hyoides*, *larynx*, &c. whose muscles are to be stretched far beyond their natural tone. The fitness of these digastrics for such an office, is pretty evident from a view of these muscles in their natural situation, and only applying the universally acknowledged effort of all muscles, to bring themselves in their contractions from a crooked to a straight state. For further evidence, let both heads of either one or both digastric muscles be pulled in the manner formerly mentioned, and the raising of the *os hyoides* will be seen: or, what may perhaps be as convincing, let any one swallow either solids or fluids, while his fingers are applied below his chin, and he will feel the swelling, hardness, and shortening of these muscles then in action.

Mr George Lauder, surgeon in this place, having dissected away a tumour covering one of the digastric muscles, caused the patient to drink while the muscle was laid bare; when he, and a numerous crowd of students in medicine, saw the muscle perform its contractions violently every time that the patient swallowed the liquor: unluckily, he neglected to desire him to open his mouth wide and quickly.

This being granted to be the proper action of the two digastrics, we may readily assign several reasons why one can scarce swallow any with his mouth open. First, The lower jaw being then unstable and moving, these muscles have not such a fixed point to resist their actions. Next, The jaw and *os hyoides* being brought nearer, the curve made by the tendon of each digastric muscle must be diminished; consequently the effect the muscle would have on the *os hyoides* is also lessened; whereas it ought rather to have been increased, because the space between the *velum pendulum palati* and the *os hyoides* is increased, by this bone's being brought down at this time. Lastly, The muscles which serve to draw down the *os hyoides* being now in contraction, they must prevent the action of the digastrici.

We may here also observe how advantageously the tendinous aponeuroses of the digastric muscles are stretched over the mylo-hyoidei muscles,
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for raising the root of the tongue along with the *os hyoides*; and how the stylo-hyoidei and digastric muscles may act more uniformly and in more convenient direction, by the tendons of the latter passing through the substance of the former.

I come now to supply the function which I have endeavoured to deprive the digastric muscles of; but must previously remark, that the opening of the mouth does not only depend on the motion of the lower jaw downwards, but also on the superior jaw being raised up by the muscles which extend the head back. This fact is strongly denied by the generality of anatomists; and really passed unobserved by me, till my ingenious friend, and *quondam* pupil, Dr John Pringle, made me remark it: and any one may convince himself of the truth of it, by putting the blade of a knife, or his own nail, opposite to the conjoined edges of the teeth when the mouth is shut; which knife being held unmoved while the mouth is opened, he may, by the help of a mirror, see the upper teeth raised remarkably at every aperture he performs. The larger share, however, of the mouth's aperture is, in the ordinary erect position of the head, made by the lower jaw's being brought down by muscles that are commonly appropriated to the tongue, *os hyoides*, and larynx; which are capable, in my opinion, of being applied not only to this use, but to some others that are generally overlooked.

In considering these muscles in respect of the lower jaw, imagine the *sterno-hyoidei* and *genio-hyoidei*, or the *coraco-hyoidei* and *mylo-hyoidei*, to act at the same time; it is evident, that the *sternum* and *scapula* being fixed in comparison of the jaw, these muscles may be looked on as digastrics, whose middle intersection is the *os hyoides*, and whose moveable insertion is the lower jaw. Imagine in the same manner the *sterno-thyroidei*, *thyro-hyoidei*, *hyoglossi*, and *genioglossi*, to act all together, they may be considered as two many-bellied muscles acting on the lower jaw, which they will be sufficient depressors of in length, strength, and manner of insertion, without standing in need of assistance from any other muscles. Besides what might reasonably be deduced from viewing these muscles, and from pulling them in the direction of their fibres in a dead body, in proof of their being employed in depressing the jaw, we can be abundantly sensible

fible of most of them acting when the mouth is opened, by laying our fingers on the teguments that cover them.

These muscles do, by the jaw's descending, lose somewhat of the advantageous insertion which they have when the mouth is shut; for the *os hyoides* will descend so much less than the jaw-bone, as the contraction of the muscles situated below the *os hyoides* is less than the joint contraction of these muscles, and of the others that go from that bone to the jaw. To mention an example: Suppose the *sterno-hyoidei* and *genio-hyoidei* only to act, the chin will be brought proportionally so much farther down than the *os hyoides* descends, as the quantity of contraction of both *sterno-hyoidei* and *genio-hyoidei* is greater than the contraction of the *sterno-hyoidei* alone; in consequence, then, of the chin being brought nearer to the *os hyoides*, the muscles between these two bones come to have a more oblique direction to the jaw, or to have their angles of insertion diminished, and their force in pulling the jaw down lessened, on that account. One advantage, however, is hereby obtained, that the root of the tongue, *larynx*, &c. are not removed too far out of their place; and that loss of advantageous insertion is compensated another way: for, when the muscles above and below the *os hyoides* are considered as digastrics, it is evident that this bone being placed farther back than the insertion of the muscles into the jaw, a considerable curve must be made at this bony intersection of these muscles; and therefore, by becoming straighter in their contraction, they must draw the *os hyoides* forward, by which this bone becomes more perpendicular to the jaw, and the muscles obtain necessarily a more favourable direction. But, in all positions of the *os hyoides* in respect of the jaw, the obliquity of the muscles backward is great enough to oblige the condyles of the lower jaw, when advanced on the tubercles, to slide back into the cavities in the time of their action; by which, as I hinted formerly, luxations are prevented.

This motion of the *os hyoides* forwards and downwards, which can be felt by laying a finger on this bone when the mouth is opened, leads us naturally to account for the use of the ligament which is sent out from the styloid process of each temporal bone to be fixed to each appendix of the *os hyoides*: for its direction is exactly such as prevents this bone from being drawn too far out of its place by the muscles that open the mouth; whereas

whereas it can be of little effect towards supporting the *os hyoides* and other parts connected to it, unless it had been more perpendicular. I imagine the resistance which these ligaments make to the muscles below the *os hyoides*, to be one reason why these muscles do not bring the *os hyoides* so far down proportionally to their lengths, as the others above it seem to depress the jaw, in opening the mouth: Which action I found to be performed by the several parts concerned, in the following proportion; by straining, I can open my mouth, when the head is in the most natural easy position, till the distance between my anterior *dentes incisores* is $1\frac{1}{2}$ inch, to which the extensor muscles of the head contributed somewhat less than half an inch by raising the upper jaw, the *os hyoides* descended about as much more than half an inch as the upper jaw wanted of it, and consequently the muscles between the lower jaw and *os hyoides* contracted one third of the whole space. I chose this straining posture, because any other degree of opening the mouth cannot well be determined: but I am at the same time sensible, that, where no such violent contraction of muscles is required, the proportional motions of these parts will be different from what I have just now described them; and, when the head is extended very far back, the lower jaw only is moved in opening the mouth, whereas this action is chiefly performed by raising the upper jaw when the head is bended much forward.

Supposing, then, the *mylo-hyoidei*, *genio-hyoidei*, *genio-glossi*, *hyo-glossi*, *sterno-hyoidei*, *coraco-hyoidei*, *thyro-hyoidei* and *sterno-thyroidei* muscles always to be employed in drawing down the jaw conjunctly, (whereof however in ordinary occasions some may be unactive), the force they are capable of exerting will be considerably less than that of the levators. From thence we may learn, how the whole parts being left to their natural action, the lower jaw may be supported and the mouth kept shut by the superior power in the levators; whereas the depressors in their voluntary contraction (which is vastly greater in all muscles than the natural) may be capable of overcoming the natural force of the levators. Hence also we may see the reason of the jaw's falling down by its own weight, when the natural contraction of all the muscles is weakened by palsy, drunkenness, or sleep; or how, on the contrary, the mouth is violently kept shut,

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when the muscles are preternaturally contracted, as in convulsions, inflammations, &c.

These muscles, which are so well adapted for depressing the lower jaw, are capable of performing very different functions when the lower jaw is kept firm by the muscles which raise it. If they act at different times, the most remarkable of their actions will be these; the *genio-glossi*, *hyo-glossi*, *genio-hyoidei*, and *mylo-hyoides*, will pull the *os hyoides* and tongue upwards and forwards. If with these the thyro-hyoidei act, the larynx will also be brought along with the other parts; if with all yet mentioned the sterno-hyoidei and coraco-hyoidei act, the larynx only will be brought nearer to the *os hyoides*. If the thyro-hyoidei alone act, the *os hyoides* and thyroid cartilage will approach each other proportionally to their mobility. If the sterno-hyoidei and coraco-hyoidei act with the former, the *os hyoides* will descend to the cartilage. If to these the sterno-thyroidei are joined, then the tongue, *os hyoides*, and larynx, will be brought down. All the other combined actions of these parts are easily deducible from those mentioned. If these muscles act all together, and the jaw is kept firm at the same time by its levators, they have an effect not so generally remarked; which is, the bending of the head forward, the articulations of the head and of the superior vertebræ being the nearest moveable joints: And, in this action, these muscles must have very great advantage by the great distance of their insertion from the centre of motion; or, in other words, by the length of the vectis they act with. As an evidence of the fact, let any one's head be pulled or pushed violently backward, his jaws are pressed strongly together, and his throat is tense with his larynx advanced, while he strains to resist the force applied: This the painters seem to have been abundantly more sensible of than the anatomists.

The sum of all I have argued for, concerning these muscles, may be deduced in these few propositions.

The digastric muscles serve to draw up the *os hyoides* and parts annexed to it in deglutition.

In opening the mouth, the head is extended, and the whole muscles of any considerable length and bigness situated betwixt the sternum and chin (except the digastrici) are put into action, the *os hyoides*, &c. are drawn

drawn down and advanced forward ; if the jaw-bone was brought forward, it is made to slide back.

When the mouth is kept shut, or the jaw-bone is made firm by its levators in any degree of the aperture of the mouth, that range of muscles just now mentioned may either contract successively, and then they act as commonly described ; unless that, by being variously combined, they may be differently determined to pull up one part, or to depress another : Or, if all the muscles act together, they conspire to bend the head forward.

WHEN the condyles of the lower jaw are luxated, the mouth stands open, and cannot be shut. This Mr Petit (*a*) ascribes to the direction of the fibres of the muscles that raise this bone, being so altered in respect of the condyles, that these processes come to be situated in a straight line drawn from the origin to the insertion of the muscles ; and therefore these muscles can have no other effect than to press the condyles closer to the temporal bones. It is evident, however, that this cannot obtain in most of these muscles ; as, for instance, in the masseter and internal pterygoid : nay, the external pterygoid would seem to gain as much more in this morbid situation as the temporal lose ; and I have seen people labouring under a luxation of the lower jaw, whose mouth stood open to a certain degree, but they could still open it farther, and bring it back again by the elevator muscles of the jaw. The plain cause of the mouth's not shutting in the luxation is the slipping of the coronoid processes under the anterior root of the zygoma, and their being pressed on that bone : which is, I suppose, one reason why, after attempting the reduction of such a luxation, by simply pressing or striking the fore-part of the jaw upwards ; or, after applying any other force that presses the coronoid processes violently upon the bones of the upper jaw ; a tension and inflammation may be brought on the parts hereabouts, and particularly on the temporal muscles ; which afterwards may be followed by all the other symptoms of a pricked, bruised, or wounded tendon, taken notice of by Hippocrates ; because the tendon of the temporal muscle of the luxated side must suffer these very injuries, by being intercepted betwixt the corone and the *os maxillare* or *maxillarum*.

This cause of the mouth's remaining open in a luxation which I have assigned, was the common reason given for it before Mr Petit, and is strenuously defended by one of his critics (*a*): therefore I needed not have mentioned it, if Mr Petit's book was not in the hands of a great many young students here, and the other known to few; and I hope the other circumstances added, which are at least not so commonly remarked, will plead my excuse.

I HAVE more than once found Mr Petit's method of reducing the luxated jaw-bone ineffectual, after the muscles had been swelled by unartful attempts of reduction; but have succeeded by a very small improvement on that excellent method: which was, to wrap linen so thick round my two thumbs, that I could scarce introduce them betwixt the posterior grinders; then taking hold of the base of the jaw with my fingers, and applying my palms under the chin, I pressed down and pulled forward the posterior part of the jaw with my fingers and the points of my thumbs, which is the whole of Mr Petit's method; and at the same time, I thrust the anterior part of the jaw upwards with my palms, so that, the jaw being made use of as a lever to which the last joint of the thumbs served as a prop, I acquired a considerable additional force, to which the muscles were obliged to yield, and the condyles were disengaged entirely from the zygoma, and brought down, after which they slide backwards with the least assistance, and the reduction is fully made.

When the thumbs employed, as just now described, have not force enough to make the reduction, my friend Dr Simpson, professor of medicine at St Andrew's, makes use of a round piece of wood eight or nine inches long, one end of which is cut into the form of a wedge, to introduce it between the teeth of the luxated side, with the thinnest part as far back as the posterior grinders; when, having the head secured, and raising the chin, he pushes the other end of the wood upwards to depress the back part of the jaw with the thin end, by which the force is much greater than the thumbs can exert.

THE origin and course of the CHORDA TYMPANI being described
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(*a*) Dissertation au sujet des ouvrages de l'auteur du livre sur les maladies des os.

by few authors, and scarce delineated by any in the natural position, and the figure easily admitting of the representation of the inferior maxillary branch of the fifth pair of nerves, as it comes out of the skull, and divides into its branches, I have caused that nerve and the *chorda tympani* to be painted, which I shall say, with the generality of anatomists, proceeds or is sent off from that nerve, though I rather incline to think it a branch of the *portio dura* of the seventh pair united to the fifth. The *chorda tympani* takes its origin most frequently from that branch of the fifth pair that is bestowed on the tongue; but I have seen it sometimes rise from the trunk which furnishes the branch given to the tongue, and the other that enters the posterior hole of the lower jaw. The chorda immediately after its rise runs backwards and outwards, involved in a cellular substance, till it sinks within the bony part of the *tuba Eustachiana*. The situation of the skull in drawing this figure would not allow me to delineate more of this chord, without destroying some parts that were chiefly designed to be illustrated here: wherefore I shall refer to *Tab. xiii. and vii. of Du Verney's Traité de l'organe de l'ouïe* for what remains of it; and seeing our common systems, nay the authors who have expressly treated of the nerves, pass the description of this nerve generally very slightly, I shall translate Mr Du Verney's description, which is the fullest and most exact I know.

“ The little nerve (says he, page 51.) that crosses the tympanum, has
 “ its origin immediately from the branch of the fifth pair of nerves,
 “ which descends to be distributed to the side of the tongue. This little
 “ nerve ascends to the exterior side of the bony part of the *tuba Eusta-*
 “ *chiana*; and, following the course of the external (commonly called now
 “ the oblique) muscle of the malleus over which it lies, it enters by the
 “ same aperture into the tympanum: then it passes under the tendon of
 “ the internal muscle, and, descending obliquely from before backwards,
 “ it lies upon the membrane of the tympanum; and, passing before the
 “ long leg of the incus, it at last escapes out of the cavity of the tympa-
 “ num, to enter into a small canal formed in the *os petrosum*, and is joined
 “ to the *portio dura* of the auditory nerve, a little before the *portio dura*
 “ makes its exit from its canal.”

The only remark I have to make on this description is, That I am at a
 loss

lofs how to underftand the words, *It lies upon the membrana tympani (a)*; for it does not appear to be immediately contiguous to that membrane.

I have alfo caufed the *Tubæ Eufiachianæ* to be represented in this figure, in full view, that one, by fupplying in his imagination the *velum pendulum palati* and *uvula* depending obliquely from the edge of the palate-bones, or by confulting Du Verney's *tab. ix. fig. 2.* may eafily underftand the true fituation of the orifices of the tubæ, which fome anatomifts feem not to be entirely well acquainted with, though it is an anatomical fact neceffary to be exactly underftood; efpecially if it fhall be found, that the method of injecting medicines by this canal for curing deafnefs in feveral cafes fhall prove fuccefsful, which there is a great probability it fhould, and of which Mr Guyot gives a good inftance by relating his own cure (b). The inftument he made ufe of for injecting the medicines is defcribed at great length by Mr Garengéot, in his treatife of *chirurgical inftuments*.

By authors neglecting to explain the method they took to represent the parts delineated in their figures, difengaged from all the others to which they are naturally contiguous and adherent in the body, I have often obferved younger anatomifts utterly at a lofs to fearch out the parts, which they imagined they underftood exactly the fituation and ftructure of, from the representation authors had made of them. To prevent fuch an inconvenience in the prefent cafe, I fhall inform the reader how the bones appear fo bare, and yet the fofter parts which were defigned to be represented are preferved entire.

Mr Cowper, who both drew and engraved the following figure, not having been formerly in ufe to work upon anatomical fubjects, I put a fkull perfectly cleaned in the proper attitude, and let him draw it at his leifure; then I caufed him to fupply the other parts painted from the firft recent fubject I had afterwards, whose fkull was very near of the fame dimensions, having previoufly made the bones as bare as I could without boiling or macerating, and without injuring the foft parts defigned to be illuftrated; which method has had a good effect, by making the whole figure more fimple and beautiful.

EXPLI-

(a) Il fe couche fur la peau de tambour.

(b) Hift. de l'Acad. des Sciences. 1724.

EXPLICATION of PLATE II. Fig. I.

- A, The occipital bone.
 B, The lamboid future.
 C, The great hole of the occipital bone through which the *medulla spinalis* passes.
 D D, The condyles of the *os occipitis*.
 E E, The mastoid processes of the temporal bones.
 F F, The styloid processes.
 G G, The zygomatic processes.
 H H, The holes through which the lateral sinuses and eight pair of nerves pass.
 I I, The passages of the carotid arteries.
 K K, The external wings of the pterygoid processes of the sphenoid bone.
 L L, The internal alæ.
 M M, The external ears.
 N, The left temporal process of the sphenoid bone.
 O, The back part of the vomer.
 P P, The part of the parotid glands lodged in the back-part of the cavities which receive the condyles of the lower jaw.
 Q Q, The *tubæ Eustachianæ*.
 a, The tubercle of the left temporal bone on which the condyle of the lower jaw moves when the maxilla is drawn forwards.
 b, The cavity behind that tubercle wherein the condyle is commonly lodged. The surrounding ligaments hinder this cavity from being fully represented.
 c, The ligament which connects the moveable cartilage to the temporal bone.
 d, The moveable cartilage of the right side brought forwards on the tubercle that it might be fully seen.
 e, The circular ligament which connects the cartilage to the condyle of the jaw.

f, That

f, That part of the external pterygoid muscle which is inserted into the moveable cartilage, and serves to pull it forwards.

gg, The third branch of the fifth pair of nerves coming out of the skull.

bb, The branches of that nerve given to the temporal and masseter muscles.

ii, The *chorda tympani* sent off from the branch of that nerve which is distributed to the tongue.

FOR the sake of young anatomists, whose imagination might not be able to supply the want of figures to explain what is above written, those on Plate I. are given: Where,

Fig. 6. is a copy of as much of Cowper's tab. xxiii. *Myotom.* as relates to the parts in question, with the addition of two or three pricked lines; the view here represented being a direct one of the left side, with the head reclined towards the right, and the muscles in an unactive state.

A, Denotes the base of the lower jaw, to which the anterior head of the digastric muscle is fixed.

B, the part of the temporal bone from which the other head of the digastric rises.

C, The *os hyoides*.

D, The internal jugular vein filled with wax.

E, The anterior head of the digastric muscle.

F, The posterior fleshy belly of the same muscle.

Gg, The middle tendon common to both these heads.

H, A strong aponeurosis sent from that tendon to the *os hyoides*.

i, Part of that tendon raised into a convexity forwards, by the over-distended jugular vein.

K, The *stylo-hyoid* muscle, through which the tendon of the digastric passes.

L, The extremity of the *stylo-hyoid* muscle, that is fixed to the *os hyoides*.

Fig. 7. Represents the direct anterior view of the *stylo-hyoid* and digastric muscles, with the *os hyoides*, when the head is drawn much back.

The letters common to this figure, with the former, denoting the same parts,

parts, a comparison of the two figures will shew what the effect of the different attitudes is.

Besides what is common to both, *q q* here point out the great curve of the round tendons to be at the same part where the strong aponeurosis *H* goes off to the *os hyoides*.

P is the thin aponeurosis of the digastric muscle, spread upon the mylohyoid muscles.

You see, then, that Mr Cowper paints no ligamentous pulley here for the round tendon of the digastric muscle to move in; nor has he any in tab. 31. *Myotom.* where the digastric is again represented: but in both he delineates the aponeurosis fixed to the *os hyoides*, which he mentions in his description, num. 68. as a constant thing, as I always find it. But he is obliged to acknowledge (notwithstanding the fondness he expresses for being the first who shewed the mechanism by which the digastrics act on the lower jaw) that the tendon passes through the stylo-hyoidcus, and an annular ligament, or sometimes a membranous inclosure. I still affirm, that I never saw any ligament, such as ties down the muscles of the hand, fingers, foot, toes, or any other muscle, whose action is determined by a band, or ligament, to any direction different from the straight course of its fleshy fibres; and that what is called the annular ligament of the tendon of the digastric muscle, is no other than the common cellular membrane, which stretches with the least force drawing it, and readily rises into cells upon blowing air into it.

Some have fancied that the stylo-hyoidcus muscle serves as a pulley to the tendon of the digastric: but any who have ever dissected muscles, must know, that their fleshy fibres are connected to each other by such weak fibres as can make very little resistance; and, in dissecting this part of the stylo-hyoidcus muscle, we scarce can hold it with a hook or forceps so tense as to dissect it clean, without the risk of tearing its fibres asunder; which plainly shows it to be too weak for the use they assign it. They ought to have also considered, that the tendon has no curve where it passes through this muscle; which is a sure sign that the muscle does not serve as a pulley to it.

Though there were a pulley through which this tendon passed, it could be of no use, so long as the tendon is tied to the *os hyoides*; for the apo-

neurosis H hinders its play, in the same way as threads tied to a cord laid over a pulley, and to the screw or ropes by which the pulley is suspended, prevent the motion of the cord.

It has been said, that though there is a great curve in the middle of each digastric muscle when the head is extended backwards, yet it becomes straight when the head is bended forwards; and that, when these muscles are straight, they may bring the lower jaw down.—To this it may be replied, 1. That the digastric muscles never are straight; there is a curve in them when the chin touches the breast. 2. If they were to pull the jaw down, they must draw the *os hyoides* upwards and backwards; whereas this bone descends and advances forwards when the mouth is opened. 3. In this situation of the head, bended so greatly forwards, which is supposed to be the proper one for the action of the digastric muscles, the mouth is not opened by the descent of the lower jaw, but by the upper one only being raised.

One may readily judge from the figures what the action of this digastric muscle must be. If the posterior head, F, alone act, the middle tendon will be drawn backwards till the aponeurosis shuffles from *m* to *o*; which is a very small space in Mr Cowper's figure, and must be much less in mine; after which, this head acts on the *os hyoides*.

The anterior belly, E, acting alone, the extremity of the aponeurosis, H, is brought from *m* to *n*; which is as much as this head could be expected to contract.

If both heads act while the *os hyoides* is not kept down, the muscle becomes straighter, approaching the line *r*, till its axis is placed in that line; which I have endeavoured to prove is the proper office of this muscle in deglutition, in which it is assisted by the stylo-hyoideus, K.

If both heads contract while the muscles which pull the *os hyoides* down are in action, the tendon G will be raised towards *r*, till the aponeurosis H is made straight and tense. Both bellies then continuing to contract in this situation, they will conspire in their efforts to draw the *os hyoides* upwards; besides which, the anterior head pulls also the jaw A. Before the jaw can be depressed, the *os hyoides* C must be so firmly kept down by its muscles, that it shall be more difficultly raised than the jaw can be depressed; otherwise E would move the *os hyoides* upwards, without

out any effect on the jaw. Since therefore the jaw can be depressed with no greater force than what is employed to pull the *os hyoides* down, it will necessarily follow, that whatever diminishes the force pulling the *os hyoides* down, must hinder, instead of assisting, the depression of the jaw. But in the present supposition, of both heads of the digastric muscle contracting in the situation above described, it is evident, that the posterior head can have no effect on the jaw, but exerts its whole force in pulling the *os hyoides* upwards, by which it counteracts the muscles, i. e. diminishes the force that draws the *os hyoides* down, (which the anterior head cannot increase), and consequently the jaw is depressed, or the mouth is opened with less force, when the digastric muscle contracts, than when it is unactive. From all which, especially if joined to the experiments mentioned in the article to which this is a supplement, it appears evident to me, that the depression of the jaw is no more the office of the digastric than the extension of the fore-arm is the office of the *brachæus internus*.

THE preceding article * having been severely criticised, without convincing me that I am in the errors imputed to me, I think myself obliged to offer what arguments I can in support of these articles.

My first critic is the famous Mr Winslow, one of the greatest masters in anatomy, to whom the world is infinitely obliged for numerous improvements and discoveries, and who appears, from his writings, to be a scrupulously honest man.

The second is Mr Ferrein, who has given several specimens of his accuracy and ingenuity, published among the memoirs of the French academy of sciences, and in his other writings.

The third is Professor Walther of Leipzig, who is author of numerous anatomical, physiological, and medical tracts, which shew him industrious and learned.

These gentlemen have argued so differently, that I must consider each by himself.

* When first published in the Edinburgh Medical Essays; being Art. xi. of Vol. I. and Art. xiii. of Vol. III.

ANSWER to Mr WINSLOW.

MR WINSLOW (*a*) observes, 1. That at the end of Vol. I. of the Medical Essays, &c. published in 1733, notice is taken of his *Exposition Anatomique*, published in the year 1732. 2. That Dr Douglas's translation of the exposition was published in 1732. 3. That the 3d volume of Essays was published in 1735.

I fancy the meaning of these observations is to insinuate, that I was the first aggressor; and therefore, to set this matter in its true light, I must remark,

1. That our Vol. I. which is properly for June 1731—May 1732, was published in 1732, notwithstanding the booksellers having put 1733 upon its title-page, according to the common practice of people of that business when they publish books near the end of a year; and that this volume was stopped several weeks at the press, after more than two thirds of the sheets were cast off.—When my remarks on the articulation, &c. of the lower jaw, were read to the Society in 1731, and when they were printed, I knew no more of the exposition, than that a system of anatomy was long and impatiently expected from Mr Winslow.

2. There must be a typographical error in the second observation; for 1734 is on the title-page of Dr Douglas's translation of the exposition; nor could a translation of such a book have well been published sooner after the original.

3. When vol. iii. of Essays was published, I did not know Mr Winslow's opinion concerning the point now in dispute, but did not see reason to embrace it.

The observations are followed by an accurate account of Mr Winslow's doctrine, and then mine is attacked.

On my argument of the digastric muscles being too short for drawing down the lower jaw in opening the mouth (*b*), it is remarked, (p. 185, 4to. p. 259, 12mo.) that the lower jaw being a crooked lever, a small motion at its angles

(*a*) Mem. de l'Acad. des Sciences, 1742, p. 178 of 4to edit. or p. 239 of 12mo.

(*b*) See p. 235, *supra*.

angles must make a considerable one at the chin; and that the digastric muscles may be regarded as if their insertion was towards its angles, therefore a small quantity of contraction of the fibres of these muscles is only required.

All will agree, that the motions of the several parts of the lower jaw, and of every other bone, are in proportion to their distances from their common centre of motion; and therefore the angles of the jaw move much less than the chin does. But this is no reason why the digastric muscles should be regarded as if they were inserted into the angles, when they are inserted into a part of the jaw which has a much larger motion than the angles have, in proportion to which motion they must contract; and the quantity of this contraction must be according to the length of their fibres, which I still think are too short for such an office. This is confirmed by the dissection of quadrupeds and birds, whose digastric muscles depress the lower jaw; for in them these muscles are not inserted into the fore-part of the jaw, but much nearer to its centre of motion.

In stating my second objection, Mr Winslow has twice omitted the word *proportional*, and from thence is led to criticize me (p. 187, 4to. 251, 12mo.) for what I have not said.

I have so good an opinion of Mr Winslow's integrity, that I shall give this hint, without entering into any argument, believing that it will be sufficient to make him with these remarks had been omitted.

In answer to this 2d objection, (p. 187,—252), and in some other parts of his *Memoire*, Mr Winslow also interprets what I called the angle of insertion of the digastric muscles, as if I meant by it the curvature of the tendons of these muscles.

What has occasioned this mistake, I cannot tell; for I have always named them differently: and I thought every one had known what is meant by the angle of insertion of a muscle into a bone, to wit, the angle between the muscle and the bone; and that the nearer this angle is to a right one, the muscle always acted, *cæteris paribus*, with greater advantage.—In the present question, it might be easily demonstrated, that the nearer perpendicular a muscle fixed at one end to the *os hyoides*, and to the chin at the other end, is to a line drawn from the axis of the jaw through

through the part of the *os hyoides* where the muscle is fixed, the larger angle it must act with in drawing the jaw down: consequently the digastric muscles act with a larger angle when the head is reclined back, and with a less one as the chin is depressed; that is, these muscles have a less angle of insertion as they continue to act; whereas most other muscles obtain a larger angle of insertion as they act. Thus when the fore-arm is extended, the *biceps* and *brachii internus* are inserted at a very acute angle; but as the fore-arm bends, the angle of their insertion increases.

Whether the aponeurosis of the digastric muscles is long and loose enough, to shuffle as much as is sufficient for their action, if they were depressors of the jaw, is the next point in which Mr Winslow and I differ, and which other anatomists inspecting the parts must determine.

After this I am blamed (*Mem.* p. 189—254) for considering the actions of each head of the digastric muscles separately; and, by repeating this critical remark afterwards, Mr Winslow seems to think that these muscles always act simultaneously, or at the same time.

If I had neglected to consider the simultaneous action, I had been to blame: but as this was done, there could be no fault in examining what each head can do; because I have no doubt of their often acting separately, as I see different parts of other muscles act, which seem to be more made for co-operation than these two parts of the digastric muscles. Thus, for example, when the arm hanging by the side is to be raised by the deltoid muscle, its middle part only can act at first, because the fore and back parts of this muscle being then placed below the centre of motion of the joint of the arm, might, if they acted, pull down the arm with as much force as the middle part could exert to raise it: and, on the contrary, when the arm is to be pressed to the ribs, the lateral parts of the deltoid muscle contract, while the middle part is inactive.

In relating my 4th objection (*Mem.* p. 189—254), there are two mistakes in translating my words, which have given ground for criticism. Where I say the *os hyoides* is kept firm, or a little brought down, *brought down* is translated *poussé en embas*, pushed down; whereas the evident meaning in French is *abaissé*, or *tiré en embas*.—Instead of translating the English words, *is the only supposition to be allowed*, by the French words *est la seule chose que je suppose*, the translation ought to have been *qu'on doit toujours supposer*.

After

After Mr Winslow has mentioned how people may be deceived in making trials of the actions of the muscles in dead bodies, he blames me (*Mem.* p. 190—256) for reclining the head backwards when I was to examine the digastric muscles, and says that I ought to have made the dissection with the head in the ordinary erect posture.

In making these experiments, I did not free the muscles from any attachment which could have effect on their actions: I did no more than lay their external side so far bare as I could take hold of it with a hook, or put a needle into it. And I still think the experiments ought to be made with the head reclined backwards, rather than in any other posture; for this obvious reason, that it is in the reclined posture only that living people, evidently and without a dispute, cause their lower jaw to descend in opening the mouth; and therefore, if the digastric muscles ever have any effect in pulling down the jaw, it must be in this attitude. I made the trials in all the postures; but mentioned this one particularly, as being the most decisive of the question in dispute.

I know not what use Mr Winslow intends should be made of his observation, That, in the most erect posture, “ the middle curvature of the “ digastric muscles, called their *angle* by Mr Monro, is much less than “ the ordinary manner of dissecting has given occasion to attribute to “ them.” It is certain that these muscles never are straight in any posture, and that Mr Monro never gave the name of *angle* to their curvature; and, in the erect posture, I see nothing in these muscles to persuade me they are fit for pulling down the jaw, unless the experiment is made, as Mr Winslow has sometimes done, after taking away the adhesion of the middle tendon of a digastric muscle to the *os hyoides*, (*Mem.* p. 180—242).

I am also at a loss to know, what advantage Mr Winslow can have in the present argument, by considering the lower jaw as a crooked lever, as he has done (p. 185 & 191, 4to. 249, 357, 12mo.): For a power acting on or drawing one end of a beam, the other end of which is the centre of motion, has the same force or effect, whether the beam is straight or crooked, provided the power acts in both with the same angle of insertion, and same distance from the centre of motion.

It is acknowledged (p. 192—258,) that, when the head is reclined back, and the *os hyoides* is kept firm, “ it is certain the posterior heads of
“ the

“ the digastric muscles cannot act, and consequently can do nothing for “ the motion of the lower jaw:” But then, as the keeping firm or bringing down, or, as Mr Winslow is pleased to quote me, the *pushing down*, the lower jaw, is said to be only a supposition which is not to be found in a natural state, as is afterwards to be demonstrated, the conclusion which might otherwise be drawn cannot, it is said, be made.

There is no such demonstration as Mr Winslow here promises, to be met with in this Memoir; and the keeping firm or bringing down the *os hyoides*, when the mouth is opening, is so far from an imaginary supposition, that every person, putting a finger on the *os hyoides* while he opens his mouth, can be certain of its being a constant evident fact; and therefore Mr Winslow himself is here excluding the posterior heads of the digastric muscles from any share in the motion of the lower jaw downwards.

Unless the keeping the *os hyoides* down is again mentioned as an objection to my 5th section, there is none made (p. 192—258).

When Mr Winslow knows, that, in the original of my 6th objection, the person endeavouring to feel whether the anterior heads of the digastric muscles are in action, is desired to do it while the mouth is opened ever so wide, quickly or *strongly*, which last word is omitted in his quotation of this objection, he will wish some of his reflections, which depend on his omission of this word, had not been inserted.

It is admitted (p. 195—262), that the action of other muscles besides the digastric, is to be felt while the mouth is opened; and (p. 196—264) that there is a difficulty in feeling the action of the digastric muscles, though, it is alledged, it may be felt when the points of the two thumbs are put at the internal or posterior side of the bone of the chin, and resistance is made by the thumbs to the depression of the jaw.

In swallowing, any person may feel the anterior heads of the digastric muscles in action, without having accurate knowledge in anatomy: I desire only a comparison to be made, between the feeling of these muscles when even the least forcible deglutition is performed, and when the most straining effort is made to open the mouth. In deglutition, these muscles are tense, hard, and swelled; in opening the mouth, their action cannot be distinguished: They then feel no more tense than the traction of the

os hyoides, then drawn downwards, would make them ; nor more protruded outwards, than the swelling and rising outwards of the muscles above them could cause.

In proof of the posterior heads of the digastric muscles acting in opening the mouth, it is said (p. 196—265), that, “ when the fore-finger is “ pushed between the lower part of the mastoid process and the angle “ of the lower jaw (as also a little more forwards), and then the finger is “ pressed strongly, while the jaw is drawn down with effort to the last “ degree, the belly of the digastric muscle of that side may be felt very “ distinctly as a kind of stretched cord, especially, if at the same time, the “ chin is borne up by the thumb of the other hand, to resist the effort of “ drawing down the jaw.”

I did not expect Mr Winslow would have insisted on this posterior head acting in opening the mouth, after acknowledging it certain, that, “ if “ the *os hyoides* is kept firm, (which it most undoubtedly is), this posterior “ head can do nothing for opening the mouth in the reclined or extended “ attitude of the head, in which the mouth is only opened by the descent of the lower jaw ;” and when there cannot be so much as a pre-tence for the favourite bascule, or reversion of the upper part of the head upon the condyles of the maxilla. Since, however, he appeals to this trial, I must observe, that, in making it, no tense cord is felt in some people : in many, it is felt ; but in these it is very different from what is felt when deglutition is performed, both in its form and situation. In this latter action, one can distinguish the tension of the tendon, and the swelling of the belly of the muscle : In opening the mouth, the cord is higher, deeper, and without any perceivable swelling in one part more than another : and, therefore, I understand it to be the ligament extended from the styloid process of the temporal bone to the *os hyoides* (a), sustaining the *os hyoides* ; or that it is the stylo-hyoideus muscle performing that office, when there is no such ligament, as frequently is the case (b).

The last argument in the *Memoire* for the digastric muscles drawing down the lower jaw in opening the mouth, is (p. 182—245, p. 191—257, p. 197—265), the dissection of quadrupeds and birds, in whom the

K k muscles

(a) Ruyfch Advers. dec. 3. § 9. Cowper Myot. in fol. Tab. 24. c. Tab. 27. fig. 1. DD.

(b) Weitbrecht, Syndefinolog. sect. vi. § 15.

muscles analogous to the human digastric, are not connected to the *os hyoides*, but are extended in a straight course to the lower jaw, to the middle or back part of each side of which they are fixed, and evidently draw it down.

I agree with Mr Winslow both in the anatomy and uses of these muscles in quadrupeds and birds; but will not admit his conclusion, that the human digastric muscles have the same office: for these muscles of these creatures have not the curvature in the middle, nor the connection to the *os hyoides*, nor the insertion into the chin, which the human digastric muscles have, and which are the circumstances upon which my objections to the common account of the action of these human muscles are founded.—If any person was to argue thus, The human digastric muscles are principal instruments in deglutition, therefore the analogous muscles of quadrupeds and birds are also organs of deglutition; Mr Winslow would refuse this conclusion to be just, for the same reasons as make me not to admit his conclusion.

After objecting to the common doctrine concerning the digastric muscles, I took notice of both jaws contributing to the opening of the mouth; the upper part of the head only moving when the chin is near the breast; the lower jaw only moving while the head is extended fully back; and both jaws moving in all the intermediate situations of the head, each of them moving nearly proportionally to the greater or lesser flexion or extension of the head. In proof of this, I desire any person to put a knife, or his nail, opposite to the conjoined edges of the teeth, before the mouth is opened, to hold the knife or nail unmoved, while, standing before a mirror, he opened his mouth in all these different attitudes of the head, and then he might see these motions of the jaws.

In the reflection on these experiments (*Mem.* p. 198—267), Mr Winslow seems to think, that, “when there is not space enough to make a large opening of the mouth by the descent of the lower jaw, one is naturally prompted to raise or recline the head backwards proportionally to the extent of space necessary to make the opening of the mouth by the ordinary depression of the lower jaw; and that it is thus that crocodiles raise the head to make a large throat, according to the observations on three crocodiles related in the Collection of old Memoirs.”

If,

If, in opening the mouth, while the chin is near the breast, all the head was first raised, and then the lower jaw descended, there would be some reason for this reflection : but, as the lower jaw is not in the least raised, but keeps its situation, while the upper part of the head only moves, it cannot invalidate what I have said ; and there cannot be any intention of making space for the descent of the lower jaw, when this jaw is not to descend.—The Academicians, whom Mr Winslow quotes, evidently thought of crocodiles raising their upper jaw and cranium by the muscles placed on the back-part of the vertebræ of their back and neck.

In the same reflection (p. 199—268) it is said, That, in the experiment I proposed for seeing the motion of the jaws in a mirror, the person extends his head, that he may look into his throat:—Whereas the experiment succeeds, whether the person sees, or is blind ; whether he knows for what purpose it is made, or is ignorant of it ; whether he holds the knife himself, or another does it without his knowledge. In short, whoever makes the trials, or sees another do them, with a mirror, or without one, must be convinced I have described what really is done in opening the mouth.

I am surprised the reflections above mentioned were insisted on, since they contradict the bascule, or reversion of the upper part of the head upon the condyles of the lower jaw, argued for (p. 181—243, p. 184—247) ; which I would next examine, if it were not more proper to consider it in my remarks on Mr Ferrein's *Memoire*, where it is more fully treated than in Mr Winslow's.

Whether the uses I have mentioned of the muscles below the *os hyoides*, to wit, the sterno-hyoidei, coraco-hyoidei, &c. are assented to or denied, (p. 195—262), I cannot say : for though it is admitted, that, “ in great efforts to bring the lower jaw down to the last degree, and by this to open the mouth greatly, the tension, and a kind of hardness from this tension, of these muscles, are felt ; yet it is said, that one shall not distinguish any hardness by the contraction of their fleshy fibres, nor any shortening by that contraction.”

Any person putting his finger on the skin which covers these muscles, while he moves his lower jaw, can determine as well as the most accurate anatomist what these muscles then do ; and therefore I shall appeal to

every one's feeling for determining this part of the debate. My colleague Dr Rutherford, Mr Gibson surgeon at Leith, and I, were consulted about a tumor in the thyroid gland of a very lean lady, in whom the coracohyoid, sterno-hyoid, and sterno-thyroid muscles raised the skin covering them, on even the least motion made by her lower jaw in speaking to us, and then felt as firm hard cords under our fingers.

After Mr Winflow has finished his reflections on the article in general, he criticises the illustration (a); but has nothing new in his remarks, except blaming me, (p. 202—272) for making use of figures of the parts put in a wrong attitude, and particularly the one I had caused to be drawn of these parts as they appear when the head is reclined back.

I have already said, and beg leave to repeat, that this is the most proper attitude in which the digastric muscles can be examined in order to pass judgment on the dispute between us, because it is in this posture that the opening of the mouth is solely made by the descent of the lower jaw; and therefore, if the digastric muscles are the organs which pull down this bone, then it is that their action must be greatest, and consequently most manifest.

I should have thought myself very happy in being prevented from causing any original anatomical figures to be drawn, which I probably would have been, had Mr Winflow given us the figures of all the parts of the body, as he intended; for, had the painters and engravers executed their parts with the same accuracy and candour, as he would have dissected and presented the originals to them, we should have had by far the most complete system of anatomy ever yet has appeared, though, as frailties must attend human nature, even a Winflow might have erred. Long may he live to do still more service to mankind; but I am afraid his great age will not bear the fatigue of such laborious work as these plates would require.

ANSWER to Mr FERREIN.

THE Academy of Sciences at Paris has published two Memoirs of Mr Ferrein, relating to the motions of the jaws, in their Transactions for

(a) P. 248, *supra*; or Art. xiii. of Vol. III. of Med. Essays, &c.

for the year 1744. In the first of which there is (p. 427, &c.—579, &c.) a description of the articulation of the lower jaw agreeing with mine; except that, 1. (p. 427—579) The substance interposed between the two pieces of which the lower jaw consists in infants, and between most other bones of the head, ought, it is said, not to be called a cartilage, as is commonly done, but a continuation of the periosteum.—2. (p. 329—580), The substance which lines the cavity that receives the condyle of the lower jaw, is likewise said to be no cartilage but a simple membrane.—3. (p. 430—582), The elastic *meniscoid interarticular* cartilages are affirmed to be ligamentous bodies.—4. (p. 430—582). The external and internal parts of the articular ligaments, which are thicker than the fore and back parts of these ligaments, according to the common rule, of the ligaments of the articulations by ginglymus being thicker at the sides to which least motion is allowed, are here esteemed four ligamentous cords.

Seeing self-defence alone obliges me to take up the pen at present, and none of these four specialities are particularly designed to criticise me, I shall enter into no dispute about them.

The motion of the jaw forwards, or its horizontal motion, is described in the *Memoir*, (p. 431—584), in the same manner as in my essay; but (p. 431—584, p. 432—586) it is asserted, that authors have expressed themselves so obscurely concerning the motions of the jaw backwards, that it was impossible to know what they thought.

Whether is it impossible to understand the following words, (p. 232, *supra*)? “The exterior extremity of this oblong posterior cavity is “made very narrow by the *meatus auditorius externus* being considerably “advanced forwards here, which again prevents the condyle ever to “be pushed so far back as to be in hazard of doing any injury to “the gland situated in the more internal part of the cavity.” Whether is not this a more particular account of the non-recession of the lower jaw, than to say in general, as is done in *Memoires* 1744, (p. 433—586) that, it is owing to the construction of the parts, and the opposition of the ligamentous cords?

Mr Ferrein, observing that the condyles are too much straitened in the glenoid cavities for performing the large motions which the lower jaw makes.

makes to each side, (p. 434—588), is astonished, “that an observation so simple, and a truth so striking, has escaped the eyes of so many anatomists.”——Has he not overlooked the following words of the Essay, (p. 233, *supra*)? “The condyles can be moved laterally when they are lodged in the cavities, or on the tubercles; but these lateral motions are much more confined in the cavities, because of the surrounding brims.”

Both anatomists and surgeons knew that the condyles of the lower jaw did not always advance and recede together, but were capable of being moved forwards or backwards, separately or alternately. They are, however, obliged to Mr Ferrein for his minute description of these motions, and their effects on the different parts of the jaw, (p. 435—588; p. 443—599.)

In p. 439—594, Mr Ferrein has made a very pretty discovery, and has corrected an error into which all the anatomists had fallen, concerning the manner of the motion of the lower jaw in its depression and elevation. The condyles had always been thought the axes upon which the lower jaw moved, as most other bones do upon their articulated ends; but Mr Ferrein has demonstrated the axis of motion of the lower jaw, in its motions upwards and downwards, to be a little above its angles: so that when the body of the bone moves downwards, its condyles advance forwards; and when its body is raised up, the condyles recede back: by which, says he, the parotid glands are safe from compression, as the muscles which raise the jaw are far from being overstretched; and it may be added, that the nerves and blood-vessels which enter the internal posterior hole of the jaw, are likewise saved from being twisted, overstretched, or torn, in the motions of this bone.

I shall conclude my remarks on this first memoir of Mr Ferrein, by observing, that his account of the aperture of the mouth, and experience, confirm what I have said (p. 234) of the danger of a luxation of the lower jaw when the mouth is opened, and the condyles are on the tubercles of the temporal bones. It is in vomiting, coughing, yawning, &c. that these luxations ever happen: so that he should not have quoted this opinion as erroneous, p. 444—602.).

THE first thing Mr Ferrein undertakes to prove, in his second memoir,
is,

is, (p. 511—687), “That the head contributes to make the opening of the mouth, and that it even contributes considerably; but by a motion independent of the will, and of the contraction of the splenius, complexus, and other muscles which raise the head; in a word, by a motion reciprocal to that of the lower jaw, resulting from the effort that is made to depress the lower jaw, and occasioned by the resistance which it opposes to its depression.”

I suspect I do not rightly understand this proposition: for I am at a loss to know what motion can be independent of the will, which results from an effort, and which is said (p. 540—729) to be an effect of the act of the will; and I am not certain whether the reciprocal motion here mentioned is Mr Winslow’s bascule, or reversion of the head upon the condyles of the lower jaw. I suppose it is; and therefore am now to perform the promise I made in my answer to him.

As an introduction to Mr Ferrein’s demonstration of the foregoing doctrine, he mentions the following law in mechanics: “I suppose two bodies, A and B, fastened to the two ends of a cord which shortens itself; it is evident that the cord draws these two bodies, the one towards the other, in making them pass over spaces reciprocal to their masses; and that if the mass A is double or triple of the mass B, the space which the mass B moves shall be double or triple of what A moves.”

If the force with which the cord shortens itself is less than the resistance of the mass A, how much space would that mass A move? None surely. This is the case of muscles, which almost perpetually act with a force which moves only the more moveable of the two parts to which their ends are connected. In proof of this I shall take Mr Ferrein’s own examples of the fore-arm and leg, which he has brought (p. 512—688) to prove his mechanic law.—When the leg or the fore-arm alone is to be extended, its muscles move it only; so far is according to the rule I just now said is generally observed: But, says Mr Ferrein, the reason why the thigh or arm do not move at the same time, is the resistance made to the motion of the thigh and arm by the almost enormous mass of the trunk, &c. which must be moved with them.—Let us suppose this a good reason; then observe what happens when one rises from a chair, if it is even on one foot. The extensor muscles of that leg raise the enormous
mass.

mass above it, and leave the leg immovable; and in the same way one having his hands on a table with his fore-arms bended, can raise his body from the ground by the action of the extensors of the fore-arms, raising the arms, and all the enormous weight of the body, the fore-arms remaining unmoved. If Mr Ferrein's law obtained in the action of muscles, and if a leg and foot, or the two fore-arms and hands, are one tenth or eighth of the weight of the whole body; then, in these cases of rising from a chair, or raising our weight on our hands, the leg or fore-arms ought to move only one tenth or eighth less space than the thigh or arms move; whereas they move none. Thus muscles move only the least resisting part of the two they are connected to, though the difference of the resistance is but one eighth or tenth; nay, if a man rises with a weight in his arms, or on his back, the difference may not be one twentieth or thirtieth.

After assuming this mechanic law of muscles moving both the parts they are connected to, it is inferred, (p. 502—689), that “the principles which are established, are certainly sufficient to demonstrate, that the effort which one makes to open the mouth, ought to tend at the same time to depress the lower jaw, and to raise the upper one.”

Admitting the law in mechanics to have been demonstrated, and justly applied to the action of muscles, and granting every thing yet mentioned in this memoir, this consequence would not follow; because there has yet been no proof brought of a contractile cord extended from the head to the lower jaw.

In applying the law we have been disputing about, “Mr Ferrein says, (p. 513—689), “I have discovered, that, notwithstanding the head's being nearer the trunk than the lower jaw, yet the resistance which the head makes to its elevation is extremely little, and such nearly as it would be if the head was wholly separated from the spine. I have also found, that the resistance of the lower jaw, though really less, (meaning, I suppose, than that of the head), is however considerable enough to occasion in the head the motion which I have attributed to it,” to wit, the elevation.

One must read the subsequent page of the memoir before he can understand what the resistance of the head wholly separated from the spine is, which

which is here intended. It is, I suppose, the resistance to elevation which the head makes, when its upper part is made to move on the condyles of the lower jaw.

The heads of people falling asleep, or of children and of weak persons, when they are in an erect posture, bend down on their breasts; and whoever raises the head of a man in a faint, may find, that, in doing it, he must employ a considerable force. So that the resistance to the elevation of the head is not extremely little: And seeing it is here acknowledged, that the resistance of the lower jaw is less than that of the head, it will be concluded, from the foregoing experiments with the legs and fore-arms, and many more such might have been named, that, supposing a contractile cord to be extended from the back-part of the head to the lower jaw, this cord would only move the lower jaw, which is confessed to give the lesser resistance.

In the subsequent paragraph, there is an acknowledgment which I heartily wish had been more attended to. The words of it are, "In truth, the reciprocal motion of the head upon the lower jaw cannot be made, if the processes articulated with the spine (these must be the condyles of the occipital bone) do not follow the determination which the motion of the head gives them."

The condyles of the occipital bone are the fulcra on which the head rests, and on which the motions of the cranium and upper jaw, independent of the spine and lower extremities, must always be performed. Whoever affirms, that the condyles of the lower jaw can be the fulcra and axis of these motions, might as well say, that a beam, AB, placed on the rigid pillar C, could ever have its axis of motion on the end D of another beam DE, joined to AB by a hinge; where it is evident, that, on raising the end A upon the axis D, the other end B of the beam must make its way down through the substance of the pillar C, as the pricked line *ab* does in fig. 9. (Plate I.):—Or, if we would suppose, as in fig. 10. that the beam FG, supported by the pillar H, is to have its end F moved downwards upon the axis I, the end of a beam KI fixed to FG by a hinge; then it is evident, that FG must rise greatly from the end of the pillar, as the pricked line *fg* does in the figure. It is almost needless to add, that the cranium and upper jaw are here represented by the lines

L I

AB,

AB, *ab*, FG, *fg*. The pillars C and H are instead of the spine; and the crooked lines DE and IK are in place of the lower jaw; on the supposition of whose condyles being the axes of motion of the head, the spine must be immensely compressible and elastic, to be lengthened and shortened so greatly in the opening and shutting the mouth.

It is in vain to endeavour to elude the force of this objection to the reversion of the head upon the condyles of the lower jaw, by saying, as Mr Ferrein does, (p. 514—690), That “the motion of the head on the first
“ vertebra of the neck, and on the lower jaw, has nearly the same axis.”

— Mr Ferrein knows very well how much farther back the condyles of the occiput are than either the glenoid cavities, or tubercles of the temporal bones, with which the lower jaw is articulated: for, of the space between the occipital condyles and the fore-part of the jaws, the distance between these condyles and the middle of each cavity, at the back-part of the tubercle, is about one fifth; and the distance between these condyles and the middle of the tubercle, is more than one fourth: But if the occipital condyles are at all behind these parts of the temporal bones, it is absolutely impossible, that while the head and spine are kept together, the fulcrum, or axis of the head, can be on the condyles of the lower jaw, or indeed any where but on the occipital condyles or spine. And Mr Ferrein seems conscious of this: for he does not affirm, that the axes are precisely the same, which they ought to be, in his and Mr Winflow’s opinion of the motions being performed on the condyles of the lower jaw; but only affirms here and afterwards (p. 517—695), that they are nearly the same.

The only way to make the head move on the lower jaw, would be, to take away its supporting pillar the spine, that the back-part of the head might be left loose and free; and then to hold the lower jaw firm. Upon comparing the axis of motion, in these motions performed by the head in this situation, it may be seen very different from what it is while the spine supports the head; whether the vertebræ are put on a table, as Mr Ferrein (p. 514—690) proposes; or whether no part of the spine is separated from the body, which is much the better way of making this experiment: The axis of motion of the head is therefore the same, whether it moves with or without the opening of the mouth.

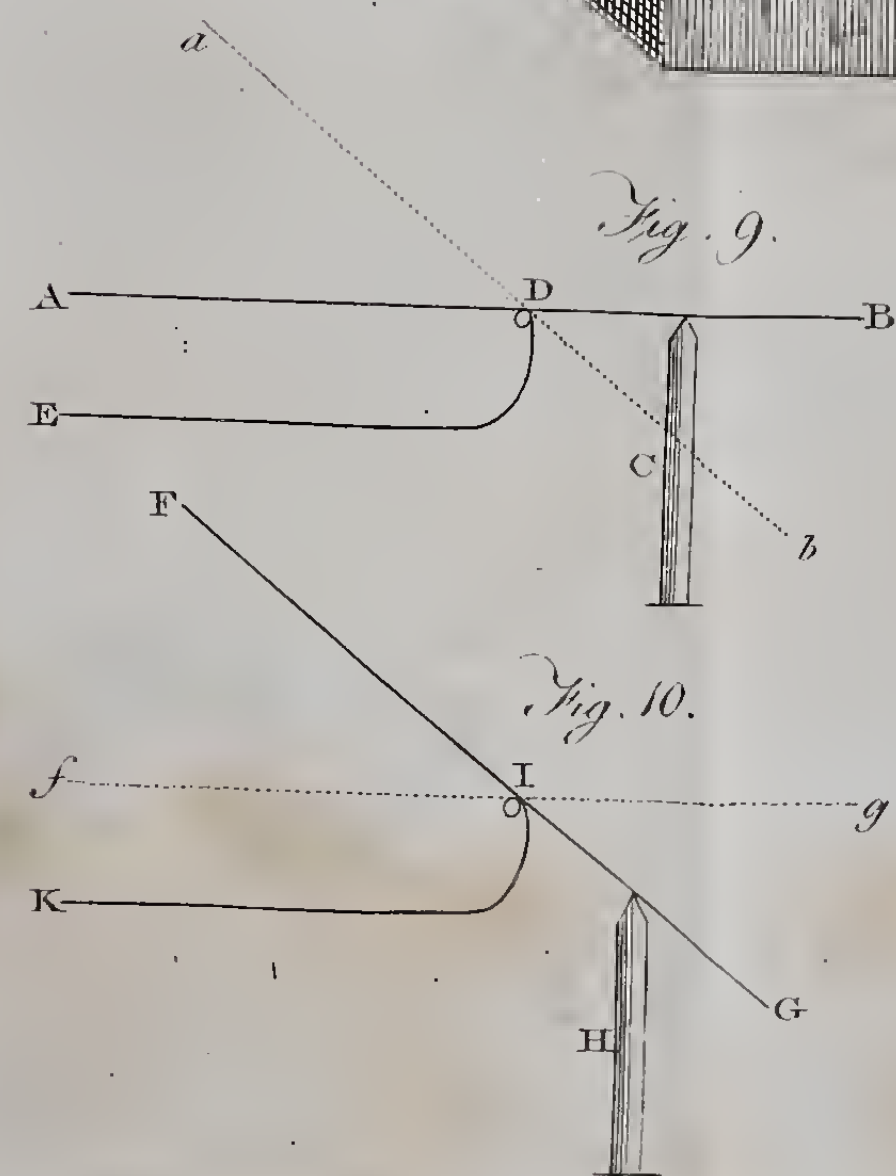
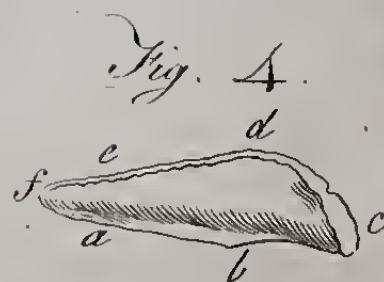
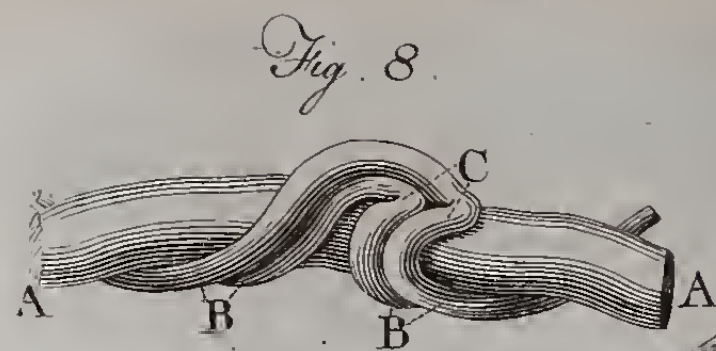


Fig. 3.

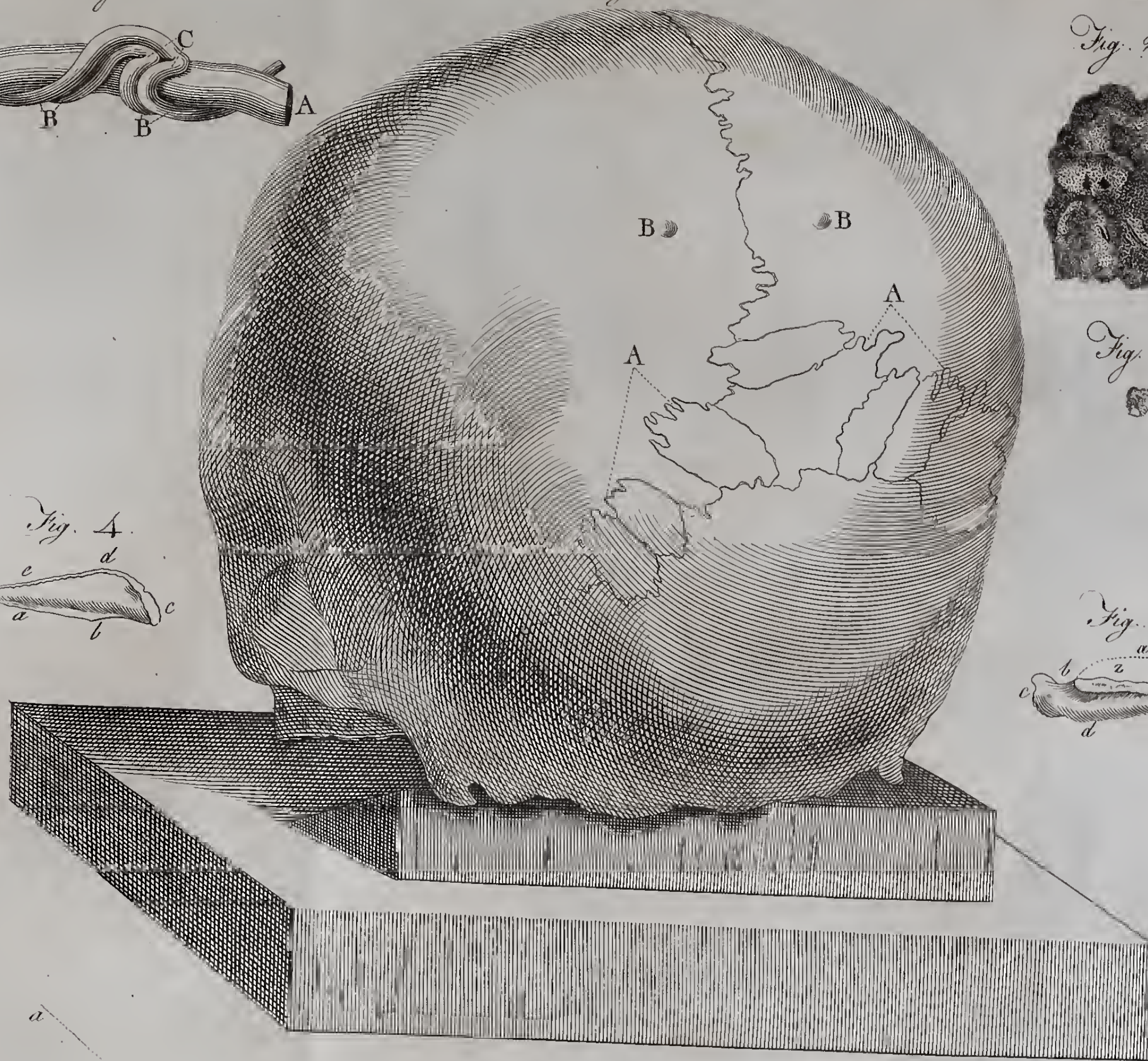


Fig. 6.

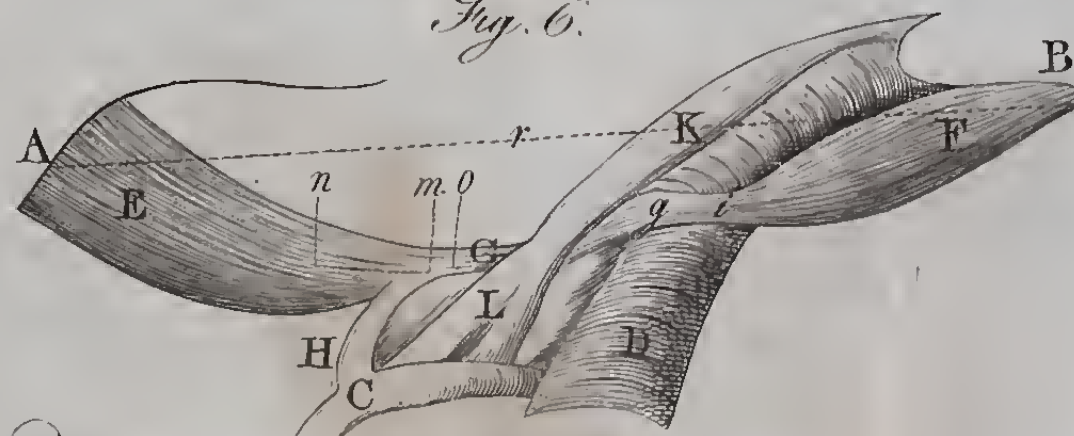


Fig. 7.

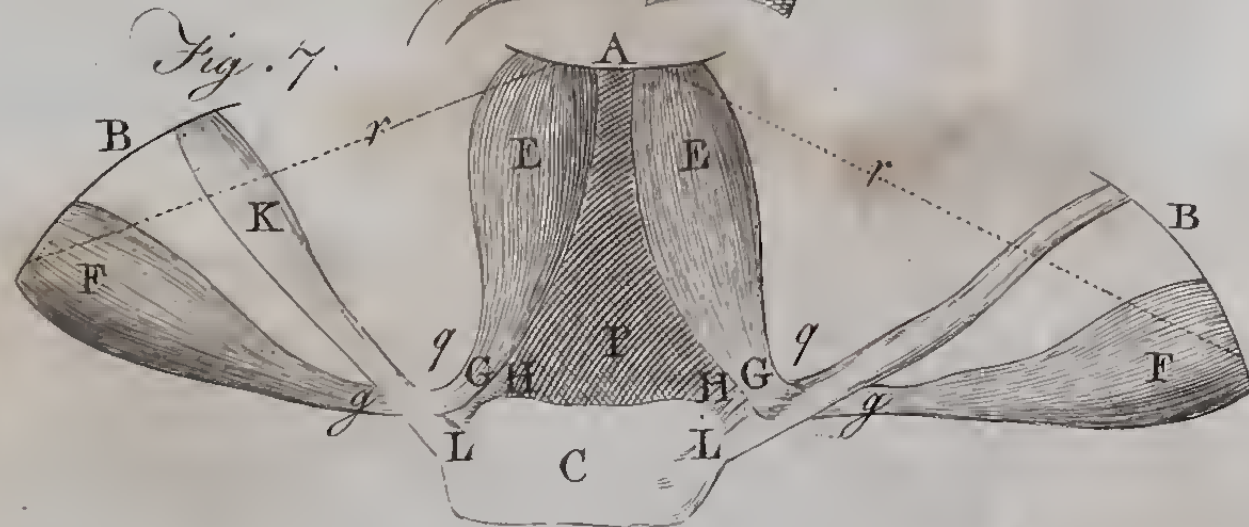


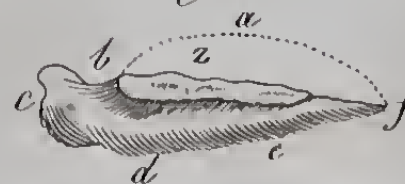
Fig. 2.

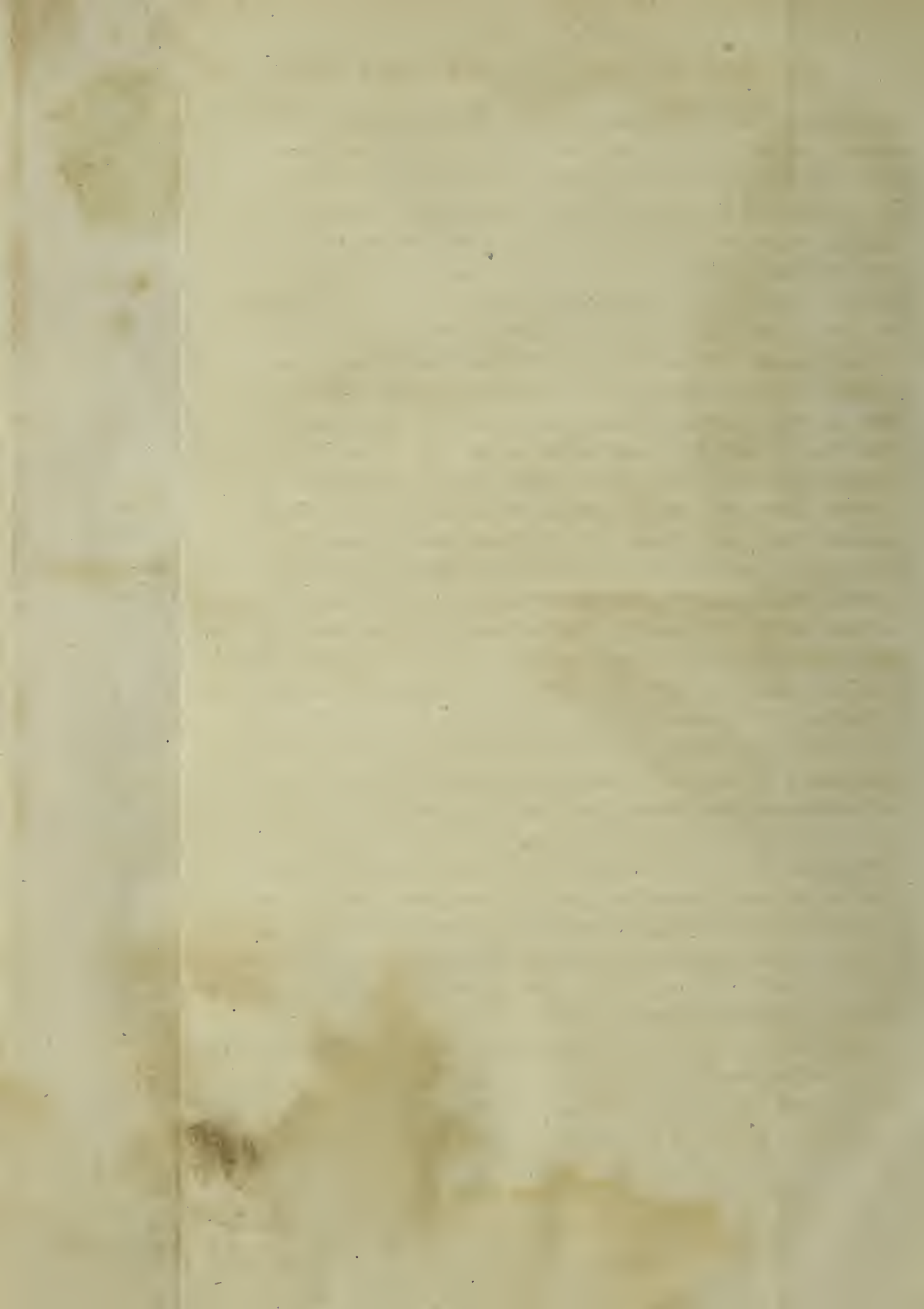


Fig. 1.



Fig. 5.





Mr Ferrein, aware that, though all his preliminary propositions were granted, yet the lower jaw must make a considerable resistance before the head could be raised, mentions (p. 515—692) four causes which conspire to make this resistance, to wit, 1. The inertia of the parts, which, as in all matter, makes them resist motion.—2. The *ployment* of the parts which compose the fore-part of the neck.—3. The connections of the lower jaw with the upper part of the neck.—4. The fleshy body of the pharynx, which is connected to the neck and lower jaw.

I am surpris'd that the first of these causes is mentioned to prevail in a pendulous member, whose gravity is making it tend downwards.—I did not translate *ployment* in the account of the second cause, because I cannot think this word is here taken in the common signification of bending, sinking, shrivelling, or shortening, which would all contribute to bring down the lower jaw: and if I was to take any notice of the 1st, or of this 2d, and the 3d and 4th causes, it would have been to enumerate them as causes which draw the lower jaw down; for they have not only gravity to cause them to descend, but the muscular contractile organs, on the fore-part of the neck, being connected below to parts which are much more difficultly moved than the lower jaw, to wit, the sternum, clavicles, scapulæ, diaphragm, whatever power of contraction they have, must be a visus to draw down the jaw.

It is, however, needless, in the present argument, to insist on a minute classing of the causes, when we every day see the jaw falling, and the mouth open, in drunken, paralytic, dying persons, or whenever the levators of the jaw become weak; nay, whenever the attention of the mind is taken off from the office of sustaining the jaw, it falls. Thus people in profound meditation generally have their mouths open; and a country-fellow stands gaping while he is gazing at the novelties of a town.—When the cheeks and the muscles, which are levators of the lower jaw, are cut in a dead body, the mouth remains open, while the head is in the erect posture.

I shall make no remark on Mr Ferrein's proof of the possibility and reality of the motion of the upper jaw in opening the mouth, (contained in Mem. p. 515, 516, 517,—693, 694, 695), but beg the reader to compare them with a few lines in p. 239, *supra*.

This section of Mr Ferrein's memoir is concluded (p. 516—695) with five remarks.

“ 1. The axis of motion in the depression of the lower jaw is, according to him, nearly the same with the axis in the elevation of the upper jaw.

“ 2. These axes are both very different from the axis of the natural motion of the head, such as is made naturally, and without constraint, by means of the splenius and complexus.”

Of the doctrine in these remarks, enough is already said.

“ 3. The reciprocal motion of the upper jaw is independent of the contraction of the splenius, complexus, and other levator muscles of the head : This is demonstrated by reason and experience.”

I see no reason for this in the memoir ; but I shall take one against it from Mr Ferrein's own doctrine, which is using what is commonly called *argumentum ad hominem*. In p. 541—730, he gives it as a maxim, “ That every muscle being connected at its two ends to two different bones, every motion of the one or of the other of these two bones, which makes one of these ends to come nearer to the other, depends, at least in part, upon the contraction of that muscle.” Now, whatever axis the upper part of the head has in its elevation, Mr Ferrein will certainly grant, that the back-part of the head descends during the elevation of the fore-part of it ; and this back-part cannot descend without the end of the splenius and complexus inserted into it coming nearer to their other end, which rises from the vertebra : and therefore, by his own maxim, these muscles, at least in part, serve to bring down the back-part of the head, and thereby raise the fore-part of it.

The experience he appeals to is, to apply the fingers upon the teguments covering the splenius and complexus when the mouth is opening ; when, he affirms, these muscles are not felt hard or tense, unless when the separation of the two jaws being come to the last degree, one endeavours to force further the opening of the mouth.

The answer to this experience is, That in every person, blind or seeing, ignorant or acquainted of the intention, the action of these muscles is always felt in opening the mouth, especially when done quickly, strongly, and with repeated jerks, the person who makes the trial remembering that they are thin broad muscles covered with thick skin and fat,

fat, and with the cucullaris muscle; so that they cannot be expected to swell so much outwards during their contraction, as a masseter, gastrocnemius, or such other thick muscle which is little covered.

“ 4. The upper and lower jaws concur in the same manner to open the mouth, since they divide the motion which produces this effect.”

Is not this the doctrine of the essay-writer ?

“ 5. It is probably the same in the crocodile, as well as in a great number of other animals. It is known that the crocodile, in opening its throat, raises the upper jaw considerably. We are assured, in the old memoirs of the academy, that this elevation is greater than the depression of the lower jaw: there six muscles are described, which are in place of the splenius, complexus, &c. and which are there said to produce the motion of the upper jaw.”

This is such an explicate declaration of these six muscles serving to open the throat, that I cannot imagine how it came to be brought as an argument against me, unless the remark which follows is thought to explain this declaration to the reverse of its obvious meaning. The remark is, “ All the muscles of which we have spoke, are only appointed to raise or bring down the head: and thus, when it is said that those which are placed upon the back-part of the back and neck serve to raise the jaw, it is not properly the jaw which is raised—but the upper jaw and the cranium; for the bones which compose these two parts are firmly connected to each other.”

In this the Academicians are guarding against their readers believing that they joined in the common opinion, which prevailed at that time, of a crocodile's upper jaw having a moveable articulation, and moving independent of the motions of the cranium, in the same way as the upper beaks of parrots move, without any intention of contradicting what they had said of the muscles analogous to the splenius and complexus raising the upper jaw.—Nay, Mr Ferrein's introducing his explication of the words of the Academicians, with *apparemment*, and afterwards with *il est à presumer*, “probably,” and “it is to be presumed,” shews that he was not convinced his explication was just, but rather that he gave it in complaisance to Mr Winslow.

In the second article or section of the memoir I am examining, Mr Ferrein:

Ferrein treats of the muscles which produce the motions of the one or the other jaw ; in which, to shun digressions, he premises some preliminary observations, which I shall consider in the same order he has put them.

1. (P. 519—698) “ In polygastric muscles, the contraction of one belly “ is independent of the contraction of another.”

I agree to this, but don't choose to adopt all the reasoning in proof of it; which, however, not relating to the subject in dispute, I shall pass without further notice.

2. (P. 521—701.) “ The inflexion of the tendon of the digastric muscle “ is produced by an annular ligament, and by an aponeurosis which is “ fixed to the *os hyoides*.”

I have described and painted the aponeurosis. Cowper (*a*) mentioned an annular ligament; and it is painted by Courcelles (*b*), who says, “ In “ omnibus subjectis non tam distincte conspicitur annulus:” and Mr Ferrein admits, that it is inconstant in its appearance; varying in its thickness and breadth, and being (p. 529—712.) frequently enough, and (p. 531—715.) very often, entirely wanting.

In the comment on this second observ. (p. 513—783), there is a little mistake committed, when it said, that my article is accompanied with two figures of Cowper, there being but one figure of Cowper's. And, immediately after, by beginning a quotation from that article in the middle of a sentence, I am made to say what I never intended, to wit, that this ring of his is nothing but a cellular membrane; whereas, by beginning the quotation five lines higher, or reading the 3d objection in p. 235, *supra*, every one may see that I denied such a pulley to the tendon of the digastric muscle, as the superior oblique muscle of the eye, or the muscles of the fingers, have to play in; unless the cellular membrane had been mistaken for a pulley. Mr Ferrein agrees with me, that there is no such pulley; though he is pleased to give the name of annular ligament to some fibres of the aponeurosis, which, rising in greater or smaller number in some subjects, must pass over the tendon, to join others which are extended from the inside of that tendon.—Whether do such uncertain fibres warrant one to lay down a general maxim, “ That “ the

(*a*) Anat. explicat. of tab. 15. et Myot.

(*b*) Icon. Musc. capit. 4. Lugd. Bat. 1743. tab. 4.

“ the inflexion of the tendon of the digastric muscle is produced by an annular ligament,” especially seeing the inflexion is always made whether there is or is not such a ligament?

The third and fourth observations in the Memoir being approbations of my doctrine concerning the curvature or tendon of the digastric, which cannot be raised without the *os hyoides*, and its want of a pulley, I shall make no remarks on the explications of them, that I may avoid more dispute than is necessary for my own defence.

Mr Ferrein, observing some fibres of the stylo-hyoid muscles joined with the digastric, concludes, in his 5th observation (p. 531—715), that “ the stylo-hyoideus muscle, and the posterior belly of the digastric, may be considered as one and the same muscle with two heads.”

If the connexion of the aponeurotic fibres of muscles should give the name of *digastric*, *trigastric*, &c. to all the muscles which have such connexion, the number of the many-bellied muscles must be greatly increased.

(P. 535—720), it is said, “ The stylo-hyoideus, and posterior belly of the digastric, are appointed to act together, and to produce nearly the same effects.”—How does this agree with the first observation, (p. 515—648), “ In polygastric muscles the contraction of one belly is independent of the contraction of another?”

The 6th observ. is (p. 335—721), “ The *os hyoides* departing from its natural situation cannot be moved from before backwards.” The reason for which is said to be, the ends of the cornua of the *os hyoides* then resting upon, or being supported by, the tendinous parts of the *musculi recti anteriores majores* of the head, which are situated immediately upon the vertebræ.

One would think, that, as muscles have a constant nifus to shorten themselves, the curve which the muscles above and below the *os hyoides* make was intended to keep the points of its cornua from resting on the vertebræ, to prevent the parts there from being hurt by the pressure of these points. And, when one is directing no effort in these muscles, but they are left to their natural action, a finger on the base of the *os hyoides* can push it back; and, when we observe the motion of this bone in deglutition, we see it recede farther back than its natural situation.

The 7th observation is to confirm what I had said concerning the
keeping

keeping firm or bringing down the *os hyoides* in opening the mouth. But, in the account of the dispute about the digastric muscles, the word *uniquement* (p. 537—723) and the word *seul* (p. 550—743) ought not to have been put; for I never said that the digastric served only for deglutition.

I am here in an unlucky situation between the Academicians. Mr Winflow, as I observed formerly, blames me for considering other actions of the two heads of the digastric muscles than the simultaneous one; and here Mr Ferrein blames me as much for considering only the simultaneous one. Whoever reads my article will find Mr Winflow has understood me best.

After what I have said concerning the impossibility of the condyles of the lower jaw ever being the fulcra or axis of the head in its motions, it is needless to show Mr Ferrein's misapplication of his observation of the maxillary condyles advancing forwards in opening the mouth, which (p. 538—725) he would have us to believe is the head shuffling back. He will see the mistake, by only trying whether he feels this shuffling backwards in the mastoid process, and whether the ligaments which join the occipital condyles to the vertebræ are long enough to allow this shuffling back of the head.

The use of the external pterygoid muscles, in bringing forwards the condyles and meniscoid cartilages of the lower jaw, is next described in nearly the same manner as in my essay; and (p. 539—727) the same action of bringing down the lower jaw is ascribed to the mylo and genio hyoidei muscles: but, in proof of this last proposition, I am made to say, that the *os hyoides* moves towards the lower jaw, when the jaw is brought down; or at least I must be inferred to say so from my asserting that the muscles above and below the *os hyoides*, having a considerable curve at this bone, must draw it forwards when they are acting.

If I had not said that the *os hyoides* is brought down and restrained from coming too far forwards in opening the mouth, there might have been some grounds for the inference above mentioned; but, as I affirm both those facts, the inference ought not to have been made from one circumstance without mentioning the other two.

The second proposition (p. 540—729) is, "The stylo-hyoideus muscle serves

“ serves to raise the upper jaw ;” the proof of which is the motion of the two jaws upon the same axis : the motion of the upper jaw is very different from the natural motion of the head, and altogether independent of the contraction of the splenius, complexus, or its other elevators ; and therefore, the raising of the upper jaw must be by the action of the stylo-hyoideus and posterior head of the digastric.

If the reader is convinced that the circumstances in the antecedent proposition are disproved, as I have endeavoured to do, he will reject the consequence here drawn.

Though we follow Mr Ferrein in his supposition (p. 541—729) of the stylo-hyoideus muscle being extended to the chin instead of being fixed to the *os hyoides*, we would not find this muscle could make any effort to raise the upper jaw : For the head always performing its motions on the spine, and the styloid process, which is the part of the head to which this muscle is fixed, being farther forward than the axis of the head’s motion, the muscle never can draw down the back-part of the head to raise the fore-part.

The 1st proof of the stylo-hyoideus raising the upper jaw is founded on the following general rule : “ Every muscle being connected at its two ends to two different bones, all motion of one or the other of these bones, which causes one of these ends to come nearer to the other end, depends, at least in part, on the contraction of that muscle. The rule, it is added, is perhaps new.”

Is it new to you, gentlemen, that muscles shorten, or endeavour to shorten themselves, when they act, and that they must be shorter when their ends come nearer each other ? And, if the rule is true, does it not prove what I formerly inferred from it concerning the action of the splenius and complexus ?

Whoever lays it down as an universal principle, that every muscle becomes shorter when it acts, or that every muscle which shortens itself is exerting its force, is in a mistake, as is evident in numerous examples. Thus, when one sits down on a seat, the extensor muscles of the legs, and the retractors of the thighs, are in strong action, yet are lengthened ; while the flexors of the legs and thighs are shortened, but unactive.—The extensors of the spine are the acting but elongated muscles, when

we bow forwards. Nay, of two muscles which seem to have nearly the same direction and use, the one may act without the other. Thus the *biceps flexor cubiti* and *brachialis internus* generally act together in bending the fore-arm: but, if the fore-arm is to remain extended, or is to be kept fixed in any degree of flexion, while the arm is to be strongly raised and drawn forwards, the biceps contracts strongly, and the brachialis is unactive; or if the fore-arm is to perform strongly the action of pronation, while it is to be bended with little force, the brachialis may act while the biceps is unactive, lest this latter muscle counteract the pronators, whose force is then principally required.

I hope the feeble crispation of the muscles which I have said to be unactive in the foregoing cases will not be called their action, in order to find a contradiction in my words. Every one surely knows the difference between the weak natural curtation of muscles and their strong voluntary contraction.

If the rule is faulty, the example of the stylo-hyoideus, as here applied to illustrate it, is one of the most unfavourable in the body, because, this muscle being fixed to a part of the head farther forward than its axis of motion, it is impossible such a muscle ever can raise the head. But, supposing the connection of this muscle to the head to be farther back than its axis, and supposing the cornua of the *os hyoides* to rest with their points on the vertebræ of the neck, can it be imagined that such slippery round points could possibly stand so firm on the slippery vertebræ as to be a fulcrum to the head in its elevation, especially too while the traction is at the other end of the cornua, and in a very oblique direction? or could such points be pressed with so much force upon the muscles covering the vertebræ without hurting them?

In my answer to Mr Winslow, I mentioned what I thought the use of the stylo-hyoideus muscle in opening the mouth: and therefore may pass Mr Ferrein's second proposition, which treats of that subject, without examination; as I may also do to his third proposition, wherein he assigns the same use to the *mylo*, *genio*, *sterno*, *coraco hyoidei* muscles, as I had done.

In his fourth proposition, (p. 543—732) he undertakes to prove, “ that
“ the mylo and genio hyoidei assist in certain cases the stylo-hyoidei to
“ raise

“ raise the upper jaw, but that the stylo-hyoidei never can assist the former to bring down the lower jaw.”

The power of the stylo-hyoidei to raise the upper jaw, and the cornua of the *os hyoides* serving as fulcra to the head in its elevation, being the foundations on which the proof of this proposition is laid, I need not do more than mention it, and refer to what has been said against these foundations of it, which may also serve as an answer to what is said of the posterior head of the digastric muscle (p. 544, 545,—734 736), where the same principles are made use of.

What is said (p. 544, 545—734, 735), of the anterior head of the digastric, is appealing to his general principle about the shortening of muscles, and repeating what Mr Winslow had said; which, being already examined, need not now be considered.

Had not Messrs Winslow and Ferrein been so fond of the impossible reversion of the head upon the condyles of the lower jaw, they might have had a better argument than any they have employed for the action of the digastric muscle in opening the mouth: They might have observed, that the posterior belly of the digastric is fixed to the skull, at least as far back as the condyles of the occiput, where the axis of the motion of the head is; and therefore, when that muscle acted, it might draw down the back-part of the head, and so raise the fore-part, while the anterior belly brought the lower jaw down.

Left some other make use of this argument against me, I must observe, that the axis of the head is much farther back than its centre of gravity; on which account the head falls forward on the breast, whenever the organs that support it are weak and unactive, as in infants, sleeping, drunken, fainting, apoplectic people, whenever they are put in an erect posture. The organs which support the head from falling forwards are the splenius, complexus, and other muscles placed on the back-part of the neck, as is evident from the head's bending forward when these muscles are cut transversely, from the retraction of the head when they are convulsed or inflamed; and many more such proofs might be named. These muscles are not only strong by their number of fibres, but they are inserted into the head in a much more advantageous way than most

muscles of the body are in their respective bones : for they are fixed into the head nearly at right angles, and at a considerable distance from the axis, that they may have a long lever to act with ; and their other end is fixed to the vertebræ, where little motion in the direction of their traction can be allowed : whereas the digastric muscles have few fibres, are fixed very near the axis, at a very acute angle, and are connected at their other end to a very loose moveable part ; and therefore can never officiate instead of the other powerful organs. Nor would the fixing of the *os hyoides* by the muscles below it render the digastric any way equal to the office of raising the head, while the action of the posterior head of the digastric would diminish the force by which the lower jaw is drawn down just as much as the power of its own action : for it must be evident, that the lower jaw can be drawn down with no greater force by muscles fixed to the *os hyoides*, than what is exerted to keep that bone down. Whenever the power is greater that draws the *os hyoides* up, than what pulls it down, it must be moved towards the jaw, which it never is in opening the mouth.

P. 547, 548—739, it is granted, according to what is in the Essay, that the mylo and genio hyoidei muscles draw the jaw backwards.

I pass several little things which may be criticised in the four following pages, to come to the conclusion of this memoir ; where it is asserted, “ That Bidloo, Cowper, and Monro, conclude it impossible to swallow while the mouth is open ; which reasoning is destroyed by experience, as “ may be observed in those who drink, pouring the liquor from above “ into the mouth.”

I can see no such assertion in Bidloo, either where, in tab. xv. of his *Anat. Corp. Hum.* he has painted the digastric muscle, nor where the lower jaw is delineated in tab. xcii. : nor is it to be expected any where in his large anatomy, because, in the preface to it, he declares, he is not to give the history of the uses of the parts ; nor have I observed it in his *Exercitationes*.

Cowper, in the explication of Bidloo's tab. xv. and in both the editions of his *Myotomy*, says, “ When we swallow our aliment, we shut
“ our

“our mouth;” which is true: but he mentions nothing of the impossibility of doing otherwise.

Monro’s words are, (Essays, vol. i. p. 114 *), “One can scarce swallow any with his mouth open:” which might be translated into French, “C’est avec beaucoup de difficulté qu’on peut avaler quand la bouche est ouverte;” which, I suppose, Mr Ferrein will allow.—The experiment of swallowing when liquor is poured into the mouth from above, does not prove it not difficult to swallow with the mouth open; and in this situation, the weight of the liquor supplies, in a great measure, the office of the digastric muscles.

The challenge of the accuracy of quotations, puts me in mind to remark, that Mr Platner, whose pen is said (p. 427—578) to have been employed about the use of one of the muscles of the lower jaw, does no more than relate some of the things which authors, and particularly Mr Winslow and I, had said, declaring, p. 14. *Nec in has lites ire, nec eas componere aulam*: “He will neither enter into nor determine this disputed question.”

ANSWER to Professor WALTHER.

IN a dissertation *de Oscitatione*, published at Leipzig in 1738, the professor, p. 12. criticises my fourth objection to the office commonly ascribed to the digastric muscles. The character which a very good judge † gives of this gentleman’s writings, obliges me to transcribe his own words, that others may know whether I do him justice.

After giving a translation of my objection, he says, “Itaque, ut luculenter adpareat, quomodo ille scriptor, hac doctrinæ suæ parte, motus componat, qui aliter a se distingui debent, hinc ita arguendo rem declaramus: Caput reclinare eundem affectum habet ac si in vivo homine id extendatur. Hinc idem erit, atque maxillam inferiorem ab inferiore, præsertim in cadavere, ubi hæc per se stupida cernitur, discedere
“jubere.”

* Or p. 238, *supra*.

† Haller, Method. stud. Medic. p. 548, dictione paulum obscuriore usus est.

“jubere, et ita os aperire. Porro, caput reclinare, idem erit, ac digastrici originis locum demittere, et, si manfiores musculi maxillam in vivis fixerint, hanc capitis reclinationem, contractione digastrici juvare; sed præter hunc casum, eundem musculum debilitare, et pro maxilla deducenda inertem reddere: nihilo minus tamen eundem, tanquam si ligamentum esset, longiorem facere, et ita intendere, simul, os hyoides non propria, naturali, ac facillima contractione musculi, sed plurium partium communi tensione ac motu, levare. Nam omni occasione, os ipsum quoque tollitur, etiam si maxillæ committantur, et tantum caput reclinetur; sicut, quod inter pomum Adami et os hyoides spatium est, ac illo tempore admodum augetur, etiam in vivis hanc rem probavit. Eadem fallacia communis atque proprii motus adfertio nititur, cum cl. Monro præsumit; toties os hyoides deorsum duci, quoties maxilla vivi hominis descendit. Verum, ubi caput erigitur, et binæ maxillæ committuntur, quin et deglutitione accidit, ut priores hyoidei musculi et pars stylo-pharyngæi os bicornæ aliquantum tollant, aut alium membranarum nexum hoc os sequatur, ut, digito altero ad mediam basin, et altero ad cornu admoto, facile percipitur. Sed, quando jam maxilla movetur, tum hoc fere levissimo modo os hyoides demittitur: imo, eo tempore, sterno-hyoideos aut sterno-thyroideos musculos non contrahi, vel exinde judicare Monro potuisset, quod hic maxillæ motus, et oris hiatus, motus proportionem, quo os hyoides descendit, creberrime superet; et maxime, quod, ore clauso, perinde ac aperto, scutiformis cartilago, sub osse hyoideo, in alterutrum latus, pari facilitate converti possit.”

The objection here, I imagine, is, that the *os hyoides* rises when the head is extended, and descends when the head is bended, though the mouth is shut all the time; the rising of the *os hyoides* in the former case being owing to the stretching of the parts, without any contraction of the muscles which are connected to the *os hyoides*, as the descent of this bone in the flexion of the head depends on the natural elasticity or restitution of the overstretched parts stretched beyond their tone.

If I had proposed no more to be done, than to observe what happened to the *os hyoides* when the head was alternately bended and extended, the objection would have been reasonable; but as I desired muscles to be drawn

drawn with hooks and threads, while the posture of the head remained the same, and appealed to the feeling of muscles hard, swelled, and tense, while the different actions were performed by a living person, this objection can have no force.

It is to be wished, too, we had been here told, how a muscle becomes weaker and unfit to do its office, by stretching it, and making it tense, as seems to be affirmed in regard to that digastric muscle; for, on the contrary, it is a doctrine generally received, that muscles exert most force when they are tense.

The particular objection to the sterno-hyoidei and sterno-thyroidei muscles acting in opening the mouth, to wit, that very frequently, in this action, the lower jaw moves proportionally more, and the mouth is wider opened, than the *os hyoides* descends, will not be insisted on by any who consider, 1. That supposing these muscles to be the only depressors of the jaw, the chin would move downwards much more than the space which these muscles contract, or than the *os hyoides* descends. 2. That muscles placed between the *os hyoides* and chin, contribute to the opening of their mouth by the contraction; the quantity of which is not so great as the defect of the chin occasioned by this very contraction is.

To illustrate these propositions, and some others mentioned in my reply to the two learned academicians, and to show some other things not generally attended to in considering the motions of the jaw, I shall make use of a little figure, representing these parts in their motions.

Let A, fig. 2. (Plate II.) be the axis of motion of the lower jaw;—B, C, D, the chin. AB, then, is the jaw in the reclined or extended state of the head; AC is the jaw in the middle or erect situation; AD is the jaw fully depressed.—Let E be the *os hyoides*; EB a muscle fixed to the *os hyoides* and chin; AC, ED, the same muscle shortened as the jaw descends; ED being in the same plane with the jaw, and EB perpendicular to that plane.—Let EF be a muscle extended between the sternum and *os hyoides*.

Hence it appears, 1. That the depressors of the jaw, being fixed at a greater distance from the centre of motion, than most other muscles are fixed to their respective bones, have a longer lever to act with.

2. Supposing the *os hyoides* E unmoved, while BE acts, the space which
EB

EB contracts, is so much less than the chin descends, as Bg, the difference between BE and CE, is less than the space between B and C.

3. Less shortening of the muscle EB is required as the chin descends, to make the chin move equal spaces; for C*b* or *gi* is less than Bg, though the space between B and C and between C and D are equal.

4. The angle ABE is larger than ACE, or any angle which could be between the muscle and the chin, moving from B to D; and the farther EB recedes from being perpendicular to AD, the angle between the bone and muscle always becomes less; that is, the angle of insertion of this muscle is decreasing as it continues to act.

5. If ever the muscle and jaw are in the same plane, as AE and ED here coincide, the muscle may draw the bone back, but can no longer depress it; and if the bone was brought lower down by any other power, this muscle would raise it, instead of drawing it down.

6. The muscle EF acting, may be considered as fixed to the point E, *e*, *e*, of the jaw; and therefore this muscle shortens itself so much less than the chin moves, as the spaces between *e* and *e*, or *e* and E, are less than the spaces between B and C or C and D.

7. If the *os hyoides* E moves downwards at the same time that the jaw descends, then the muscle EB requires to have a less quantity of contraction, than when E is fixed, to move the jaw through the same space; from C to *k*, is longer than EC, and the angle of insertion does not decrease so much, the angle AC*k* would be larger than ACE.

8. If E moves only forwards while the jaw descends, the muscle EB requires to shorten itself more than when E remains fixed. A line drawn from C to *l*, is shorter than CE, but the angle of insertion does not decrease so much; AC*l* is larger than ACE, and EF acquires a longer lever.

9. When the *os hyoides* is moved forwards and downwards while the jaw descends, the angle of insertion of EB decreases less than when it is fixed, and EF acquires a longer lever; but the quantity of contraction of EB may be more or less, or the same, according to the proportion of the advancement forwards and of the depression of E.

N^o 6.

T H E

M E C H A N I S M

O F T H E

CARTILAGES between the TRUE VERTEBRÆ (a).

SEVERAL of you, Gentlemen, saw what was shewed here last winter, as a strange uncommon fish, by a soldier. It consisted of two round plates of bone, with a flexible tough substance, about $1\frac{1}{2}$ inch thick, interposed between them and connecting them. No pressure could force the middle central part of the plates nearer: but upon pressing any side of either of the plates, they approached each other, the intervening substance at the pressed part rising outwards into a convexity, while the opposite side, where the plates were separated, stretched considerably; all these motions seeming to be performed upon a solid firm substance placed in the centre.

Some of the young gentlemen who studied under my care, searched along the sea-shore, till, near to Granton, where a young whale was cast ashore a few years ago, they found such another body; and, seeing the vertebræ of the whale near to it, they were so obliging as to bring it, with one of the vertebræ, to me.

Upon comparing the surfaces of the plates with the flat surfaces of the body of the vertebra, it was at first sight obvious, that the plates were no other than epiphyses separated from two adjacent vertebræ, and the intermediate substance was the cartilage interposed between the vertebræ. Upon cutting the soft ligamentous substance, its concentric fibres shewed

N n

them-

themselves; and it became softer gradually, till in the centre, where it had resisted all pressure formerly, it was altogether in a liquid form.

The view of the play of these two plates, by means of the interposed ligament, with a liquor in the middle of it, served to explain to me the design of the structure of the cartilages between our vertebræ, which I was at a loss to understand before, though it is of the greatest advantage.

The mucous part of this ligamentous cartilage in the human body is placed near to the posterior part of the bodies of the vertebræ; and therefore is nearly in the middle between the anterior part of the bodies and the oblique processes of the vertebræ: so that, when we stand erect, each vertebra rests upon a fluid fulcrum or sort of pivot, the motion upon which to any side is easily and quickly performed, and, at the same time, is not too hasty or unequal; for the compressibility of the cartilages gradually increases from the liquid central incompressible part towards the circumference. Without this central pivot, in moving the spine from any reclined posture to the opposite one, particularly in moving forwards a spine that was reclined far back, there would often be the greatest danger of a most violent shock of one vertebra upon another, and, indeed, of all the parts of the body supported by them; whereas this contrivance allows a very gradual change of the centre of motion of each vertebra, accommodated to the bearing of the superincumbent weight in the different deflections of the spine from an erect posture, or in raising it to such a posture.

This liquid fulcrum, too, will bear off the great pressure which the vessels of the ligamento-cartilaginous substance would suffer in our erect posture, that might be of ill consequence; while the absorption of this liquor, increased by strong pressure, will serve to account in part for the difference of stature at night and in the morning.

N^o 7.

A N

E S S A Y

O N

The C A R I E S of B O N E S.

THE nature and feat of a disease being known, there is no difficulty in understanding what chirurgical operation ought to be performed, and the effects of every part of the operation can be demonstrated; so that surgeons are inexcusable if they do not reform what is faulty in the manual part of their business. The effects of medicines not being near so evident, but requiring long and accurate observation to discover them fully, are much more liable to be mistaken. People are too hasty in making conclusions; a single case or two has too often been the occasion of fixing a general rule for the cure of diseases.—The different circumstances of diseases and patients are not sufficiently regarded, medicines being often ordered more for the name of the disease than for the symptoms of the patient.—If a cure is made, the success is attributed to the medicines, without any examination whether nature has not made it in opposition to medicines very improper to assist her.—Men of great fame have been subject to such errors, and they have been followed by the generality of practisers.—What people have embraced for truths in their youth they are unwilling to contradict afterwards, and the early impressions which our mind receives are with difficulty effaced; the human mind is the same it was in Horace's days, the *Quo semel est imbuta recens* is still true.—In so many different ways may people, acting with the utmost

sincerity and *bona fides*, be led into error about the medicines they employ in diseases.

If gentlemen would patiently and assiduously observe the circumstances of their patients, and the operation and effects of medicines:—If, after remarking the evident sensible effects of medicines, they would reason from one case to another, by observing the analogy between them; they would be convinced, that the common routine is often not to be followed, but that a more safe and effectual method of cure ought to be pursued.—If no more credit were to be given to writers than what is supported by not only their multiplicity of practice, but by their accuracy in relating circumstances, and by the reasonable indications on which their practice appears to have been founded:—If, instead of taking one or two of our cotemporaries as our constant guides, we would compare several writers of different ages, to discover whose practice was most on a rational foundation:—If these methods were pursued, I am persuaded the common practice, in a great many cases, would soon be changed.

General schemes of this kind are, I know, commonly looked upon as words of course, and as little regarded as if one was proposing a project impossible to be executed. An example of the practice in a particular disease, varied hitherto in many different ways, and most of it founded on very little reason, with a proposal of reforming it according to the plan above mentioned, may possibly have greater influence, which I shall therefore now lay before you.

In complaisance to the desire of several of my pupils, I have chosen for this example, that corrupted state of bones which surgeons name *caries*, *sphacelus*, *teredon* or *tredon*: In treating which, I shall give, in the historical way, a short sketch of what some of the most eminent writers have said upon it; next, I shall describe the different appearances I have had occasion to observe of this disease; then I shall examine the manifest effects of the different medicines which have been used or proposed for it; and, lastly, I shall consider what method of cure appears most reasonable according to the various circumstances.

In the works commonly ascribed to Hippocrates, the caries is said to be a dried pituit between the laminæ of the bones (a), or earth dried by
heat

heat (*a*), or a defect of the mucus (*b*).—The account of the symptoms is very incomplete (*c*). The prognosis is as superficial; for I see no more than that in tedious ulcers the bones are affected, and the cicatrices are hollow (*d*), and livid flesh in a diseased bone is a bad sign (*e*). As to the cure; cold is said to be hurtful to bones (*f*), and this disease is to be treated as a fracture (*g*).

Celsus gives no opinion of the cause of the caries, and describes very few of its symptoms, but is very particular in his directions concerning the cure.

His application to bones laid bare in a compound fracture is wine, oil, and suppurants (*h*). In a fissure or fracture, where it is not necessary to take out the bone, he orders a cephalic plaster, softened with vinegar, to be applied; and proposes that the same plaster, softened with a cerate of roses, should be used afterwards as an incarner (*i*). His medicine for stopping the hemorrhagy, which sometimes happens in cutting the teguments to lay the skull bare, and after raising pieces of it from the *dura mater*, is vinegar (*k*).

In the caries of bones, Celsus's method (*l*) is to lay all the carious part bare; and, if it is then doubtful how deep the caries goes, to pierce with the tereba (or pyramidal perforative) till the raspings are no more black.—If the caries is superficial, he orders it to be burnt once and again with a hot iron, that a scale may separate from it; or to rasp it till either drops of blood ouzing out, or the white surface of the bone, shew all the carious part to be taken away, when nitre (*m*) well pounded is to be sprinkled on the bone.—When the caries is deep, he advises a great many holes to be made through it with the perforative, into each of which a red-hot iron is to be put, till the bone is quite dry; for thus, adds he, the corrupted part will be brought off.—When the caries penetrates to the other side of the bone, it must be cut out.—When the extent of this deep caries is not larger than what the head of the trepan will cover, he employs this instrument

(*a*) De Carnibus.

(*b*) De Articul.

(*c*) De Morb. lib. 2.

(*d*) Aphorism. § 6. aph. 45.

(*e*) Ibid. § 7. aph. 2.

(*f*) Ibid. § 5. aph. 18.

(*g*) De Morb. lib. 2.

(*h*) Lib. 8. cap. 8. & 10.

(*i*) Ibid. cap. 4.

(*k*) Ibid.

(*l*) Ibid. cap. 2. & 3.

(*m*) Dioscorid. lib. 3. cap. 8. says, Nitre and its spuma is biting, and has the force and burning of salt.

instrument to take it out.—If the caries is large, he orders holes to be made round the edges of it with a perforative; and then, cutting the bridges between these holes through with a strong knife struck with a hammer, he takes away all the carious part.

The medicines which Dioscorides chiefly recommends for bringing away the scales of bones, or for what is now called their exfoliation, is the powder of the root of the peucedanum (*a*), and the juice of euphorbium; desiring the teguments to be defended with liniments or cerates, when the euphorbium is to be applied (*b*).

Galen defines bones to be the hardest, most dry and terrestrious parts of the body (*c*), whose qualities are cold and dry (*d*). He thought a caries in a bone analogous to an ulcer in a soft part (*e*); and that it was occasioned either by the adjacent flesh generating a bad sanies, with which the bones being moistened were corrupted (*f*); or that it was owing to a mucous humour drove to the bones (*g*).

In consequence of this general doctrine concerning bones and their erosion, with the general axiom, that contraries are the remedies of contraries (*b*), Galen must necessarily have been led to discharge all things which he esteemed cold (*i*), and to recommend driers (*k*) in a caries. He is very sparing in his recommendations of particular medicines for this disease; opoponax in ulcers of bones, and *rad. peucedani* for exfoliation (*l*), with some compounded plasters (*m*), are all he mentions.

The Greek physicians after Galen have added little concerning this disease, except some few medicines, answering Galen's intentions of cure. Paulus Ægineta (*n*) has something of a different formula for making the affected part of a bone separate; it is a cataplasm made of the leaves of the wild poppy and of the fig-tree, with barley-flour and wine; or, instead of it, he recommends equal parts of the *sem. hyoscyami* and of vitriol.

The

(*a*) Dioscorid. lib. 3. cap. 77.

(*b*) Ibid. cap. 8.

(*c*) De Ossib. in procem.

(*d*) De Element. lib. 1. cap. 6.

(*e*) De Causis Morb. cap. 11. De Medic. Art. Const. cap. 6.

(*f*) Comment. in Hippocrat. de Fract. lib. 2. § 20.

(*g*) Ibid. de Articul. lib. 3.

(*h*) Comment. in Hippocrat. Aphorism. § 5. aph. 18.

(*i*) Ibid.

(*k*) Ibid. § 6. aph. 45.

(*l*) De Simpl. Medicam. Facult. lib. 8.

(*m*) De Compos. Pharmac. f. Loc. lib. 10. De Comp. Medic. per Genera, lib. 4. cap. 13.

& lib. 5. cap. 2.

(*n*) Lib. 4. cap. 50.

The Arabians added greatly to the list of drying medicines: Most of them actually so; that is, in the form of powders: and the greater number potentially so too; that is, such as, when tasted or applied to sores, stimulate, raise heat and some degree of inflammation. They also restored the Celsian practice of burning and rasping diseased bones (*a*), which had been neglected by the Greek physicians, but has been generally mentioned by writers after the Arabians.

One of the Arabians, Albucasis (*b*), advises, in a compound fracture, where a bone is bare, to put a cloth dipped in black styptic wine into the wound; but not to make use of a cerate, or any thing in which there is oil, lest it make corruption happen to it.

Those who wrote on surgery, when learning began to be restored in Europe, in the 14th and 15th centuries, copied mostly the Arabians; but after burning the bone, which is the method of cure in the caries which the most eminent of them are fondest of, they applied oily medicines to the cauterized bone (*c*).

After chemie came to be cultivated in the 16th century, other methods of cauterizing were introduced.

Angelus Bologninus (*d*) tells us, that some in his time made use of scalding hot oil, heated roots of the asphodelus, kindled brimstone, and the water by which gold is separated from silver.

Joannes de Vigo (*e*), besides *aqua regia*, mentions oil of vitriol, *unguentum Egyptiacum*, and vitriol burnt and mixed with aquavita, as cauteries. After cauterizing, he dressed with *ung. absterfivum de apio*; and says, that, by this method, the separation of the diseased part is made in forty days after cauterizing.

Vesalius (*f*) mentions *ol. sulphuris* and euphorbium for the caries; but prefers a preparation of antimony, which he does not describe.

Fallopian (*g*) agrees with Vesalius in the form of the drying medicines to be applied, and in the management of a bone after it is burnt. The place, say they, immediately after being burnt, is to be frequently moistened

(*a*) Avicen. Tract. iv. lib. 4. Fen. iv. cap. 11. (*b*) Chirurg. pars iii. cap. 20.

(*c*) Guy de Chauliac. traité iv. (*d*) De Cura Ulcer. lib. 2.

(*e*) Pract. Medic. secunda pars, lib. 3. De Ulcere cum Osse corrupto.

(*f*) Chirurg. Magn. lib. 4. cap. 14. (*g*) De Ulcerib. cap. 22.

ened with rose water and the white of an egg, that inflammation and other symptoms may be prevented; afterwards the eschar is to be ripened with butter or *ung. tetrapharmacum*.

Ambrose Paré (*a*) says more explicitly than Albucasis, that the application of unctuous and oily, or of moist and suppurating medicines, corrupts bones: Paré seems also fonder of the simple driers, that is, the absorbent powders, than those who went before him, whose driers were as much potentially so, as actually.

Fabricius ab Aquapendente (*b*) reckons aquavita among the stronger driers; and recommends the juice of leeks, with salt, for drying bones further after they are burnt.

Gulielmus Fabricius Hildanus (*c*) is rather more positive than Paré in forbidding the application of all moist and oily medicines to bones laid bare; he seems in one part of his writings (*d*) to expect always an exfoliation from bones laid bare, though in other places (*e*) he relates examples of bones laid bare being cured without any desquamation.

Hildanus (*f*) introduced the free use of euphorbium and its tincture in spirit of wine; the acrimony of which the writers before him had warned their readers to guard against.

Marcus Aurelius Severinus (*g*) takes notice of the shrill sound, as if a void was below, which a piece of bone has when struck after its exfoliation begins. He recommends oil of euphorbium and of lime, as a proper application to corrupted bones (*h*).

Soon after Severinus's time, that is, about the middle of the 17th century, the essential aromatic oils of vegetables were introduced.

Nicolaus Tulpius's (*i*) favourite medicine for exfoliation, was oil of cinnamon with oil of sublimite.

In the latter part of the last century, not only variety of these oils were used, and different tinctures in ardent spirits, and other compositions of the

(*a*) Livre 19. chap. 31. & 32.

(*b*) Pentateuch. Chirurg. lib. 3. cap. 10.

(*c*) De Gangræn. et Sphacel. cap. 19.

(*d*) De Ulcerib. cap. 22.

(*e*) Observ. cent. iv. observ. 95. & 96.

(*f*) De Gangr. et Sphac. cap. 19. Observ. cent. i. obs. 92.—Cent. iv. obs. 21. & 95.—Cent. v. obs. 21.

(*g*) De efficaci Chirurg. pars ii. cap. 11.

(*h*) Pyrotechn. Chirurg. lib. 2. pars i. cap. 4.

(*i*) Observat. lib. 1. obs. 31.

the driers of the ancients, and of the aromatic oils, were contrived; but the alkaline salts, both fixed and volatile, such as *sal tartari*, *sp. sal. ammoniaci*, &c. came to be employed, as well as the acid spirits *ol. sulphur. vitriol.* &c. (a).

While the generality of writers at this time were so fond of the aromata, tinctures, elixirs, spirits, &c. some mention their having cured carious bones by perforating, trepanning, and cutting them out (b), or by burning and destroying them with caustics (c). Others successfully employed watery medicines (d), and dry lint (e).

Among the writers of this time, Wiseman (f) is more accurate in relating the appearances of carious bones than former authors. They generally remarked only the black colour, greasiness, roughness, spongy softness, stinking smell, and thin brown ichor, of bones when carious, with the spongy flesh growing out from them. Wiseman observes, that carious bones may be of a white, brown, or black colour; and adds, "If the white be pory, the caries may be deeper and more dangerous than if it were black and hard."

His method of cure is like to Celsus's in several particulars. He orders all the carious part to be laid bare, with caustic applied to the teguments; then to scrape the rotten flesh away, or to consume it with escharotics: where that cannot be done, because of large vessels, nerves, or tendons, in the way, he desires the orifices of the ulcer to be dilated with sponge tent, gentian root, &c. But if the cure of the caries is of greater consequence to the patient than these parts are, and they are so situated that the cure cannot be made without destroying them, he advises to cut them through to come at the bone. When the carious bone is laid bare, if the caries is superficial, he would have it rasped, and then to be dressed with the milder farcotics, or digesting ointment; in a few days after the application of which, he says, you may see the flesh thrust forth in small

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grains,

(a) See Barbette Chirurg. lib. 3. cap. 8.—Verduc Patholog. de Chirurgie, chap. 1. des Fractures.—Car. Musitan. Chirurg. tom. ii. cap. 19.

(b) Scultet. Armament. Chirurg. tab. 27. explic. & obs. 65.—Zodiac. Medico-gallic. anni 1679, mens. Decemb.—an. 1681, mens. Novembris.

(c) Lanizweerd, Observ. 90.

(d) Scultet. Armam. obs. 42. Ruysch, obs. 48.

(e) Ruysch, obs. 5.

(f) Surgery, book ii. chap. 7.

grains, which is callus.—Burning with a hot iron he frequently used with success for hastening the exfoliation.—At other times he pinched away or broke off the caries.—His medicines are the driers, chemical oils, and escharotics; only that, in several cases, where the bone lay deep, he used injections composed of the vulnerary plants boiled in watery liquors, with some ardent spirit, and a little *℥p. vitrioli dulc.*

I took notice formerly, that Hildanus expressed himself as if he thought bones laid bare must exfoliate: This came to be a general opinion, as is evident from the directions which most chirurgical authors give for treating wounds where bones were laid bare; and Belloste (*a*) tells us, it was the universal practice in his time to dilate such wounds, and to keep them open in expectation of the exfoliation. He endeavours to show the absurdity of this practice, and recommends to surgeons to endeavour to prevent exfoliation in such cases; and for this purpose, he not only advised what Fælix Wurtz and Cæsar Magatus had done before him, to wit, to bring the lips of the wound near together, and to dress seldom; but also proposed, that when a considerable space of the surface of smooth firm bones is laid bare, there should be a great number of small holes, made with a perforative of a trepan as deep as the diploë or cancelli of the bones; after which, he says, fleshy papillæ rise out from these holes, and extend themselves all over the bared surface of the bones, and the wound is soon cured without any exfoliation. This practice has been approved by some considerable men, though, so far as I know, it has not been general among surgeons.—Belloste condemns the application of acid spirits to bones, as increasing the caries; and being of opinion that the air acts by its acid on bones, he insists, in rather stronger terms than most former writers had done, that bones should be well defended from the air.

Mr Petit (*b*) is the only author of this present eighteenth century, whom I need to mention. He names the several diseases in which caries most frequently happens; and relates the symptoms by which it may be judged that a bone is corrupted: such are, the deep-seated pains preceding an abscess forming near a bone, with a livid colour and sponginess in the teguments; an ulcer continuing long near a bone; the sprouting flesh of such ulcer appearing spongy, of a pale colour, easily penetrated by a probe, and
bleeding

(*a*) Chirurgien d'Hopital, chap. 12.

(*b*) Maladies des Os, tom. ii. chap. 16.

bleeding readily without giving pain; the quantity of matter being larger than commonly comes from an ulcer of that extent; the thin consistence, brownish colour, and stinking smell, of the matter; its appearing black on the plasters, though there is no lead in their composition; feeling the bone scabrous and unequal.

Petit observes several appearances rotten bones have, which may make for many species of caries. 1. The surface of a bone may be corrupted, and may notwithstanding be pretty firm and smooth, without throwing out much matter: he calls this a *dry caries*. 2. If the surface of a bone is very unequal, with a number of small holes discharging large quantities of sanies, he names the caries *vermouillé* or *worm-eaten*, from the resemblance it has to wood eroded by small insects. 3. Flesh may grow in the interstices of the corrupted bony fibres, and may fill up the cavernulæ. 4. Sometimes the bones are imperceptibly wasted in the cancers.

Mr Petit says, the dry caries is generally the most superficial, and cures more easily by exfoliation than the other kinds; which has made him think, “that the exfoliation of bones is only made readily when the carious part “has no more communication with the vessels of the sound bone. This “communication entirely stopt gives ground to believe, that the juices “which move in the vessels of the sound part make an effort against the “corrupted part; and that these efforts, redoubled by the resistance, and “repeated every moment of life, are the cause which insensibly separates “the corrupted part of the bone.

“I perceive soon, (says he), flesh rising in the circumference of the corrupted piece, which grows more and more. I have reason to believe, “that, proportionally as the first efforts of the liquors make the separation, these nutritive juices congeal, and form flesh; and that it is the “insensible growth of this flesh which completes the separation of the “piece of the diseased bone, and thrusts it outwards. I am more certain “nature acts thus, because I find this granulated flesh in the place where “the separated piece of bone was; and that the good qualities of this “flesh make me certain that the bone is sound below.”

The motion of the corrupted piece of bone, and the blood coming out below it, are the symptoms by which Mr Petit tells us the exfoliation may be known to begin.

Our author remarks, that the worm-eaten caries, and that where flesh rises in the cavernulæ, may be of different depths in the bone, and are more difficult to cure than the dry caries.—When the quantity of sanies (which is generally bloody in the latter species of caries) is very large, there is reason, says he, to suspect it comes from the cancelli, where the marrow is contained, and where the disease frequently begins; from which, if it does not find an exit, it will kill the patient.

Mr Petit's methods of cure are these. When the caries is very superficial, and of the dry kind, he dresses it with doffils dipt in spirit of wine, as he would do a sound bone laid bare; which he affirms does not always exfoliate.—If the caries is deeper, and an exfoliation must be hastened, he applies to it *aqua fortis*, or spirit of nitre in which quicksilver has been dissolved, which he recommends as a favourite medicine, and afterwards he makes use of spirit of wine.—He discharges the exfoliating part to be taken away till it is quite loose.—If the carious part cannot be separated by these means, he recommends the red-hot iron, rasping, the perforative, and trepan, as Celsus orders.

After the caries is thus removed, Mr Petit judges by the white, thick, mild matter, firm flesh, and hollow hard cicatrix, that the bone is sound; or he dreads a relapse if the appearances are otherwise.

The general practice of our surgeons is to keep ulcers with carious bones as much dilated as they can by doffils, sponge-tent, &c. to destroy the spongy flesh with escharotics, to apply spirit of wine, tincture of myrrh and aloes, tincture of euphorbium, and such like, to the bone, and frequently to all the sore.—As these ardent spirits are applied to hasten the exfoliation in a caries, they are applied, for most part, also to sound bones laid bare, as preservatives, it is said, against their corruption, and to prevent exfoliation.

From this historical sketch of what authors have said of the caries, it is evident how little the circumstances of this disease have been considered, and what a contradictory odd medley of practice has been followed; surely all of it could not have been supported by observations tolerably made. Of late, indeed, some species of this disease have been distinguished, but the practice is too uniform in all of them. To reform this, it will be necessary to examine more accurately the appearances of this disease.

Previous

Previous to any account of the caries, it will be necessary to remark, that bones have their vessels and circulating fluids, and in short the same general texture which other parts have; so that solidity and stronger cohesion of parts are the only evident distinguishing characters of the composition of bones. Of this truth there are many proofs; such as,

1. Bones are in the state of membranes and cartilages before they ossify.
2. The hardest bones have sometimes changed back again into a soft state.
3. The granulated flesh which rises out from bones after fractures, amputations, the trepan, or in exfoliation, differs nothing from what would come from any soft part, yet in several cases becomes sound solid bone.
4. When the texture of bones is unravelled artfully, and compared with the texture of the softer parts, it appears alike in each.
5. By a chemical analysis, the same principles are obtained from bones as other parts, the proportion of these principles being different in different parts.
6. By comparing the diseases of bones with similar ones in softer parts, as I shall do in considering the different species of caries, the general proposition, of bones differing only in solidity and cohesion of parts from the other softer organs of the body, will be further confirmed.

The species of caries which I have had occasion to see, are,

I. What Mr Petit calls the *dry caries*, where the bone is pretty smooth and firm, and throws out little matter. Though the surface of the carious part of a bone, in this species, is not of a very dark colour at first, yet before exfoliation it becomes of a dark brown or black colour. An exfoliation is more easily obtained here than in any other kind. Before the corrupted part can otherwise be observed to separate, one will hear, as Severinus remarks, a shrill sound when it is struck with a probe, as if it was hollow: soon after this, the edges of the carious part rise a little, and pus, or, if pressed, blood is seen coming out below them; granulated flesh then appears at these edges; the bone is more raised gradually towards the middle, till all the carious part is separated from the new sprouting flesh, which rises upon the whole surface of the bone below, and seems to push off the carious squama, so that it becomes quite loose, and can be taken away without any violence. The ulcer is then in a fair way of curing;
and

and though a considerable thickness of bone has come away, yet, in some time after, little depression is to be felt on the surface of the bone, the new flesh having gradually become harder, till it supplies in a good measure what was taken away.

Whoever has seen the separation of a gangrened piece of skin, or of the eschar of a caustic applied to the skin, where a fissure first appears in the margin of the mortified part, pus begins to ooze out there, the division between the sound and mortified part becomes larger, new flesh rises, the separation goes on from the circumference to the centre, till the mortified part drops off, and the new flesh supplies its place: whoever, I say, has seen this, and compares it with the phenomena of the dry caries, will judge, that, allowance only being made for the rigidity of the bony fibres, which cannot contract as the fibres of the skin do, the appearances are the same in both cases; and therefore I would call the state of bones described above, the *gangrenous caries*.

II. The second kind of this disease is Mr Petit's worm-eaten caries, in which the spongy or cavernulous texture is evident. It has not such a dark colour as the former; the quantity of matter sent out from the cells of the bones is greater than in the former kind, and is vastly increased when the corrupted sanies comes out from the marrow in the cancelli. Pieces of the rotten bone may be broken off here, or they may fall away; but no regular exfoliation is to be expected, unless when by art it is reduced to the former species. The gradual wasting of the bony fibres by the suppuration is often very remarkable in this caries; a piece of bone which appeared as large as the end of one's thumb, and of a solid substance, shall become less than the point of the little finger, and so spongy that it can scarce be touched without breaking.

The worm-eaten caries, where the substance of the bone only is affected, may be compared to an ulcer of the soft parts, which has a number of little sinuses in its sides, such as I have frequently seen when hard tumors had only in part suppurated, and were not all melted down into pus; drops of matter could be seen drilling out from the numerous orifices of the small caverns in its sides.—When the sanies comes from the corrupted marrow in the cancelli, the disease is analogous to an abscess, the matter of which has eroded a number of small holes in the skin.

III. Frequently a spongy, bleeding, fleshy substance rises in all the little caverns of the worm-eaten caries; when it may be called *carnous*, and is much a-kin to ulcers with hyperfarcosis.

IV. As the soft parts are dissolved down into a mucaginous substance, which destroys their original form and texture, in the *white swellings*, as they are called; so in this disease, and some others, the periosteum becomes thicker, the bone turns softer, its surface is eroded, a yellow red spongy substance sprouts out, and, proceeding deeper into their substance, wastes the bony fibres.

The difference of the appearance of this kind from what I call the *carnous* is, that in the *carnous* the spongy flesh grows out of the caverns, while the grey or brown-coloured spongy bony sides of them still remain; whereas in the other, the bony fibres disappear wherever the spongy flesh comes, so that one can scarce determine by the probe whether or not the bone is carious. Upon scraping away this bone-consuming flesh, the surface of the bone appears rough indeed, but not much eroded nor greatly altered in its colour.

I have seen some ulcers in soft parts, where such a consuming spongy flesh rose.

V. Frequently, upon opening an abscess, one shall see at the bottom of it a white smooth bone, without its periosteum or connection to any of the neighbouring parts, except by its ligaments at its extremities. By any trials we can make, and by what we can judge from the consequence of the bone's changing its colour gradually as it continues exposed to the air, and the necessity of its coming all away before any cure can be made of the ulcer, it appears, that there is no circulation of liquors in such bones before the abscess was opened.

This way of bones mortifying happens most commonly in scrophulous patients, in whom something analogous to this is likewise often to be observed in the glands, round which a slow suppuration is made, which leaves them almost entirely separated from the surrounding parts.

VI. In one species of exostosis, the tumefied part of the bone is softer than the rest of it; and is not composed of regular fibres, nor cavernous, but as if the ossifying juice had been thrown out irregularly; over which a cartilaginous or tendinous substance is spread; and from this a firm, shining,

shining, smooth flesh grows out, which, after the teguments are removed, sends forth a thin, stinking, acrid sanies; the patient complains often of throbbing pains in it, and sometimes considerable hæmorrhages are made from imperceptible vessels in its surface. May not this be compared to ulcerated cancers of glands?

VII. In the spreading, eating cancers, which all practisers know the symptoms of, the bones are wasted as well as the soft parts; and the appearances are the same in both, unless that the bones do not consume quite so fast.

Having mentioned from Wiseman and Petit the general symptoms by which we may suspect or know that a bone is carious, and having described what different appearances I have seen in corrupted bones, I should, if I intended a regular treatise, proceed to the ætiology and prognosis of each: but the former would lead me into too large a field of dispute; and the latter would require so many suppositions as would be tedious, or would be so general as to be of little more use than the common directions laid down by practical authors easily guide one to: I shall therefore proceed directly to the therapeutics.

In treating any caries, it is altogether necessary to examine strictly all circumstances; and to discover, if possible, what cause, either general or topical, may have made the corruption of the bones, that endeavours may be used to remove it, if it still subsists. Seeing it would be very improper to pretend to give here directions for the cure of the lues venerea, scrophula, scurvy, gangrenes, abscesses, wounds, contusions, and all the other diseases which may occasion caries, I must confine myself to the topical management of the caries, without any regard to the habit of the patient, or to any other disease.

A speedy and safe separation of all the corrupted part is then the principal indication to be pursued; for executing which, you have seen from the history very many means have been proposed. To know which of these are preferable in the different cases which may be under our care, it will be necessary to consider the evident operation and effects of the several medicines proposed, which may be reduced to the following classes:

1. The insipid, terrestrious absorbents, such as powder of coral, crabs eyes, &c. put into an ulcer, where a bone is carious, can have little other effect

effect than to imbibe the matter of the ulcer; if they fall into any cavernulæ of the corrupted bone, they may remain so long there as that the matter that they imbibe may become acrid. Charpie lint is an absorbent which has not this disadvantage.

2. The powders which have aromatic or other acrid particles in them, such as *pulv. rad. aristoloch. bryon. peucedan. aloe, myrrh, euphorbium*, not only absorb liquors, but give more or less stimulus in proportion to their acrimony; and as the effect of all irritation is some degree of inflammation, which in fores is principally removed by a subsequent increased suppuration, these powders may assist to separate corrupted from sound parts.—Such of them as have balsamic particles in their composition encourage the suppuration most.—Several of them resist the putrefaction of animal-substances; and therefore may preserve a carious bone, or the matter coming from it, from such a high degree of putrefaction as they might otherwise go to.—Besides these effects on the fore, regard must always be had to their operation, if any of their particles are absorbed into the blood-vessels; for some of them produce more or less of fever, others become purgatives, &c. according to their different powers, which are known to those who are acquainted with the virtues of drugs.

3. Ardent spirits, such as *aqua vitæ, sp. v.* being liquid, can be introduced further into a carious bone than powders can; they stimulate fores, resist putrefaction, harden the fibres, coagulate the liquors, hinder suppuration, and quicken the pulse when absorbed.

4. The tinctures of the powders N^o 2. in the spirits N^o 3. partake of the nature of both; but principally of the spirit, of which the larger share of the composition consists.

5. The essential oils, *ol. cinnamom. cariophyll. &c.* stimulate, erode, resist putrefaction, and, mixed with the blood, raise some degree of fever.

6. Common oils, balsams, resins, relax, increase the putrefaction, and are allowed universally to be the most effectual suppurants and incarners.

7. Water relaxes the solids and dilutes the fluids, when nearly of the same heat with animals.

8. Vinegar stimulates and resists putrefaction; when weak, enjoys also the virtues of water; when strong, approaches to the 10th class.

9. The natural salts, nitre, sea-salt, alum, the vitriols, have different degrees of pungency, and proportionally stimulate or erode, otherwise they preserve animal-substances from putrefaction.

10. Acid spirits extracted from fossils by the force of fire, such as *sp. nitr. sal marin. ol. sulphur. vitrioli*, &c. coagulate the liquids, and mortify the solids: by being diluted with water, they approach to vinegar.

11. By dissolving metallic substances in those acid spirits, generally their corroding sphacelating power is increased, and some of them give such violent pain as frequently to bring on convulsions.

12. Metallic bodies corroded by acids generally erode when applied to sores; some of these, for example sublimate mercury, and some other mineral substances, particularly arsenic, have shaken the whole frame of the body when applied externally, and the mercurial preparations do sometimes enter the blood to produce a salivation.

13. Alkaline salts and spirits, *sal et sp. c. c. sal et sp. sal. ammoniaci, cineres clavellat. sal tartar. ol. tartar.* &c. stimulate, erode, and increase putrefaction: when absorbed, as the volatile ones very readily are, they quicken the pulse. The eroding power of these salts is greatly increased in their preparations with quicklime, as in the common caustic; which mortifies any part of a living animal it is applied to, but with remarkably less pain than what the acids or their preparations with metals give.

14. All bodies heated beyond a certain degree, and applied to our bodies, give us pain, stimulate, and inflame; when greatly heated, they mortify whatever part of an animal they touch.

15. The effects of rasping, cutting, breaking, and trepanning bones, are altogether evident.

16. In every wound or ulcer, the matter discharged into it must be the most constant application to the sides of the sore: when this matter is laudable mild pus, it is one of the most powerful good digesters, suppurants, and incarners; when it stagnates too long, or when the liquors or vessels are faulty, it may become an acrid, stimulating, eroding sanies; when absorbed into the blood, it infects all the liquors, stimulates the vessels, and is capable of producing violent disorders.

The effects I have attributed to these medicines are such as are evident to the senses, and what all who practise know, but do not always consider when

when they make use of them, otherwise they would have adapted them better to the several species of caries, and to the different stadia of each ; to the cure of which I now proceed.

Of the DRY or GANGRENOUS CARIES.

WHEN the dark colour and dry surface of a carious piece of bone show it to be fully mortified ; especially if the shrill sound and rising edges of it, with pus coming out below them, discover the exfoliation to be begun ; nature, of herself, or with very little assistance, will make the cure.

If the pus is mild and in due quantity, it will prove the best suppurant and incarner for making the new flesh thrust off the carious piece of bone ; care only being taken not to remove it too frequently, nor to allow it to remain so long as to become too acrid.

If the quantity of pus is too little, it is to be supplied by the medicines whose effects are nearest to it, so that those of the sixth class are proper, *ung. basilic. liniment. arcæi*, or such like, every surgeon employs to hasten the falling out of a piece of skin mortified by a caustic. I have often employed them with equal success in bringing away a squama of a carious bone, the separation of which would necessarily be retarded by every thing which checks suppuration and the growth of new flesh, as the common favourite medicines comprehended under class third and fourth necessarily do ; though it must be acknowledged, nature, with the assistance of the balsam of her own preparing, pus, will often get the better of all that surgeons do against her.

While the exfoliation is making, the external opening in the teguments is large enough if the pus is so evacuated, that it neither forms sinuous ulcers, nor is absorbed to taint the blood ; for otherwise it hastens the separation of the carious part of the bone more by being collected upon it, than when it has a free exit.

If, by the external orifice being small, either of the bad consequences just now mentioned happens, the aperture ought to be enlarged, either by filling it with prepared sponge, which expanding itself stretches the orifice ; or it may be enlarged by cutting with a knife, or eroding with caustic, the teguments which cover the caries ; and they are afterwards to be

kept asunder by filling the fore with soft doffils, and pressing them in gently by a proper bandage.

When the colour of a part of bone is considerably altered from what it should be in a sound state, but is not so dark as it can be judged to be entirely mortified; while there are no signs of its separation, it may prove a very tedious task to trust the exfoliation only to nature: and therefore, after laying all the altered part of it bare, if it can be done by the methods proposed in the preceding supposition, the surgeon ought to try with the perforative, or with the rasper, how deep the disease goes. If it is only superficial, a complete mortification is to be made, by applying a red-hot iron or potential cautery; after which, the case and its management is the same as was mentioned already.

If the alteration in the bone is deeper than the action of the iron or caustic can reach, the surgeon may cut off all that is suspicious with a very sharp instrument struck with a wooden mallet, which gives little shock to the member; after which, he is to promote as much as possible the sprouting of granulated flesh, such as rises in exfoliations, from the whole surface of the bone, without which no cure is made, but the surface anew alters its colour and corrupts. If it was asked surgeons, what the medicines are which would most readily procure the growth of flesh, they would readily answer in general, pus and balsamic or unctuous medicines; and such they would apply in all such cases except where bones are bare. For what reason this exception should be made, I understand not. The parts which yield new sprouting flesh with the greatest difficulty ought, one would think, to have the most powerful incarners applied to them: and now, after a great many trials, I can assure you, that no medicines so effectually prevent the corruption of bones laid bare, and assist to cover them so soon with flesh, as ointments, balsams, and dressing seldom, to have the assistance of the most effectual balsam of all, pus. With these we see daily the extremities of amputated bones covered over with flesh; and by this method I have had the pleasure to see large parts of the skull, tibia, and other such very solid bones, covered in a little time with granulated flesh, after they had been laid quite bare by wounds made even with bruising instruments, and likewise after their
exterior

exterior carious surface had been cut off as directed a little above, and a complete cure was made without the least observable exfoliation.

It is plain, that, in the case I now treat of, where the corrupted part of a bone has been all cut away, or when sound bones have been laid bare, and we wish to make a cure without desquamation, that all medicines which can mortify the exterior fibres, such are all eroding medicines, are to be shunned; as are also all such as harden and dry fibres they are applied to, so as to prevent the growing of flesh, which ardent spirits most effectually do: and therefore, of all the classes of medicines which I mentioned, there are none, except the absorbents N^o 1. and 2. the unctuous and balsamic N^o 6. and water N^o 7. which are not opposite to the indications of cure. The terrestrious absorbents are of no use; water dilutes and washes away the pus, so that some of the more active or balsamic powders and the unctuous medicines can only be the proper remedies here.

Whoever has taken notice of the progress of the exfoliation of a bone, or of the cure of a bone laid bare without exfoliation, must have seen the granulated flesh rising from every part of the surface of the bone to cover it; and that what flesh grew out from any neighbouring part, though it may lie over the bone and hide it from one's sight, yet it does not grow to the bone, and no cure is made unless by what rises from every point of the bone; nay, very often surgeons are obliged to destroy such over-lapping spongy flesh, to promote the cure: from which it is reasonable to conclude, that Belloste's dressing seldom contributed much more to the cures he performed without exfoliation of bones laid bare, than the holes he proposes to be made with a perforative into the diploë or cancelli; the flesh rising from that softer substance, overspreading the surface in the circumference of the holes, can be no better than the spongy flesh which hangs over the bone from the sides of the sore.

If, notwithstanding our endeavours to make flesh rise from the surface of a sound bone laid bare, or of one that has had its mortified surface cut off, we cannot obtain this wished for incarnation, and the surface of the bone shews its beginning corruption by a change of colour, it must be treated as above directed in the case where we supposed a superficial caries; it must be completely mortified.

When.

When the carious part of a bone is too thick for being separated either by the rasper or chisel, it is to be taken out with the exfoliating trepan, or by making a great many holes in the circumference of the caries; and then, cutting the bridges between them through, the middle of it is raised or cut off; after which, the management is the same as in the preceding case.

Very often there is not space enough in the fore to apply right the instruments proper for cutting away the carious part of a bone, and it cannot be safely enlarged. When this is the case, we can only hasten the exfoliation by fully mortifying all that is spoiled, by repeated applications of a red-hot iron or of potential cauteries. When the hot iron is to be used, the bone ought to be previously well dried, that the iron may not be extinguished by the moisture; and we are commonly desired to guard the sides of the fore with wet rags: whereas, when either the iron is to be applied from time to time, or we can judge that the exfoliation cannot be speedily made, while we wish to continue a larger external opening, the reasonable practice is of design to burn the sides of the fore into a fully mortified eschar, if some part is not to be hurt, the burning of which might be of very ill consequence; for while this dead eschar remains, less moisture will be thrown out to prevent the effect of the cautery; and the subsequent applications of the hot iron can be made with little or no pain to the patient, and the orifice does not contract.—If a carious bone, which is to be burnt, lies deep, the hot iron ought to be introduced through a canula placed upon the bone, that the iron may be rightly directed.

If the potential cauteries are chosen rather than the actual, the common caustic, prepared of quicklime and soap-lees, deserves the preference to any of those composed of the acid spirits. For it gives not near so much pain, and is not so apt to occasion convulsions: it penetrates better than the dry forms of eroded metals, and does not run so much when it melts as the more liquid acids do: it either is not absorbed, or its effects are not observed in the blood; whereas the mercurial preparations frequently raise an unexpected salivation.—The reasons given for burning the sides of such a fore as I now treat of, are equally good for forming an eschar all round the sides with the potential cauteries.—This eschar ought to be
kept

kept from separating as long as the surgeon can. The most effectual way of doing this is to soak it frequently with ardent spirits; by which management the exfoliation of the sides (pardon the expression which I use to show the analogy) may sometimes be near as long in making as the exfoliation of the bone, if the suppurants, pus, and digesting balsams, are rightly applied to it.

When the affected part of the bone is fully mortified either of these ways, the case is reduced to the supposition I first made, and is to be treated in the same way.

Though necessity obliges us to use caustics in the very deep dry caries, yet because they require so much time, and so frequent applications, before they can pierce through any considerable thickness of a solid bone, I would prefer the surgical instruments, with which the whole corrupted part can be taken away at once, wherever they can be conveniently made use of.

After an exfoliating piece of bone is moveable, the orifice of the fore ought to be made so large, by the methods formerly proposed for enlarging orifices of sores, as the separated piece can easily be brought out, and without leaving any considerable hollow ulcer under the skin: for thus the pricking pain, which a loose piece of rotten bone frequently occasions when left to work its way through a small passage, and the suppurations which may be occasioned by its remaining under the teguments, may be prevented; and there is no danger of leaving a sinuous ulcer, which may require more time and labour than is otherwise necessary for a complete cure of the fore, which needs no other treatment, after all the corrupted bone is brought away, and the sound part is covered with firm flesh, than what any common ulcer does.

The cases I have supposed may serve for understanding the different stages of this dry caries; with the management necessary in each; and therefore I proceed to the second species of caries which was mentioned.

Of the WORM-EATEN CARIES, or ULCER of the BONES.

THE cells formed in the eroded bone in this species of caries lodging and retaining the acrid putrid sanies, which increases the disease, it is necessary.

necessary to destroy all the affected part of the bone as soon as can conveniently be done.—Wherever the proper instruments can be applied, rasping, chiseling, or trepanning, according to the depth or extent of the caries, will most speedily answer the intention. After any of these operations are performed, the method of cure is the same as was proposed when we supposed these operations to have been performed in the dry caries.

When the caries comes from the cancelli of the bones, the corrupted sides ought to be taken out by one or more applications of the trepan.—If the carious part is of a large extent, the trepan is to be applied all round the circumference of it; and the bridges being cut through, it is to be all raised up. Robert Watson was received into the Infirmary for a swelled carious tibia: the teguments were all mortified by caustic, and then cut away; the operation of the trepan was performed fourteen times in the circumference of the corrupted part, and all the anterior internal side of the middle of the tibia was taken out; new flesh rose from the cancelli, and became firm bone before he went from the hospital.

If less of the firm sides of the bone are found to be corrupted than what, upon opening the cancelli, we discover them affected, care must be taken that the matter within the bone should be easily discharged.

When, by the orifice through the sides of the bone being in the lower part of the putrid cancelli, the matter easily flows out, or all the affected cavity can be filled with proper dressings, the cure may be made without taking any more off the solid sides of the bone. The late Mr Macgill and I were consulted about a girl who, after the small-pox, had an ulcer very near the internal malleolus; a hole was eroded by the matter through the bone, large enough to let one's finger enter: a probe was introduced three inches upwards within the tibia, without meeting any resistance; but, on directing the probe downwards, we felt the bone full of firm flesh. A pastil, made of myrrh, aloes, and honey, had been put every day into the bone; and the girl had a constant purging, which ceased a day after I ordered the aloes to be omitted in the dressing of the sore. An injection, composed of digestive and melrose dissolved in water with some vinegar, was thrown every day into the bone, the pastil of myrrh
and

and honey was introduced a little way, the cavity of the bone gradually filled up with new flesh, and a complete cure was made.

When the sanies stagnates because of the unfavourable situation of the aperture in the sides of the bone, one or more new openings must be made with the trepan, till either the sanies has a free exit, or all the part of the bone covering the putrid cancelli is taken away, when the common cures for other ulcers are to be employed.

If we cannot perform the necessary operations for removing a worm-eaten caries, we must burn it frequently with a red-hot iron; the directions for which operation were already given in treating of the dry caries. The hot iron seems to be preferable here to the potential cauteries; because these may sink into the cells, and erode deeper than we incline, while they might not destroy the exterior part.

When in this species of caries the sanies is in great quantity and very foetid, and the bone cannot be come at to do what is necessary for a free discharge, so that there is reason to be afraid, that not only the bone may be further eroded, but that the sanies may be absorbed to occasion hectic fever and all its fatal consequences, it will be fit to encourage the discharge of the matter as much as possible, and to apply such medicines as blunt or destroy its acrimony. It is therefore necessary to dress frequently in this case, and to wash out the sanies at each dressing with a proper liquor. Ardent spirits, the tinctures made with them, and essential oils, do indeed destroy or confound the putrid smell of such sanies, and, by contracting the vessels of any sore they are put into, lessen the discharge of the sanies: which makes them answer the old theory of their being proper medicines for the caries of bones; which disease was supposed to be owing to too much moisture thrown upon the bones, whose natural quality is dry, and therefore required drying medicines to cure them. These, I am persuaded, have been the reasons why those medicines came to be employed for carious bones. But from what has been observed of the different circumstances of caries, it is evident, that these reasons cannot be alleged for employing them in all caries: And in the very case which we now consider, and which is the most favourable for using them, there are objections to them, which make others appear more reasonable to be employed, and which, upon trial, I have found more

successful. The objections are, That ardent spirits, and essential oils, in very small quantity, or diluted, (for when pure and in large quantity they are caustic and penetrate too deep), retard the separation of the corrupted parts: they render all the ulcer callous; which is indeed of some advantage to prevent proud flesh while the bone is not separated, but is troublesome to remove afterwards: they are very readily absorbed, and produce more or less fever, which hurts the patient. Some of the most common tinctures employed, that of aloes particularly, frequently bring on a constant purging. Common digestive or honey, or both, dissolved in water, with which vinegar or some drops of an acid spirit have been mixed, more effectually correct the putrid sanies, and can be used in any quantity to wash it out of the sore, without either retarding the separation of the spoiled bone, or raising the least disorder if absorbed; but, on the contrary, preventing the mischief which the absorbed sanies would otherwise produce.—When the ulcer is deep, this medicine ought to be thrown into it from a syringe, that it may penetrate every where, and may bring the sanies away with it when it recoils.

Of the CARNOUS CARIES, or ULCER of BONES with HYPERSARCOSIS.

THIS disease differing only from the immediately preceding in the addition of spongy flesh growing in the cells of the bone, the general indications of cure alter very little: only, as this flesh bleeds easily, and obstructs the surgeon's view, the rasping, chiselling, and trepanning, cannot be so proper here as the cauteries for destroying the corrupted part; and seeing the liquors constantly oozing from the spongy flesh soon extinguish the hot iron, the potential cauteries are preferable to the actual cautery. The application of the caustic will require to be frequently repeated, because this kind of caries is generally very deep; and therefore it will be convenient to make an eschar round all the sides of the ulcer at the first application of the caustic, and to keep it as long on as we can, by soaking in ardent spirits, that it may serve as a fence for preventing the future caustics from spreading too far, or giving pain. The moisture which the spongy flesh in this disease spues out, especially when irritated, is so great, that I have daily dressed such sores with powder of common

mon caustic, removing a considerable quantity of gelatinous stuff which collected on the surface, where the caustic had been applied instead of the eschar, which uses to be made in drier parts.—If the caustic makes an adhering eschar, it is in vain to apply any more caustic till that eschar separates; which is to be hastened by suppurant ointments.—By such repeated applications of common caustic, I have in a very short time consumed a whole metatarsal bone of the great toe of an adult, and have penetrated into the cancelli in the middle of a tibia, the lesser and more spongy bones consuming sooner.

What has been said of the two former species of caries, will readily make one know what further is to be done in managing the different stadia of this caries; it is sufficient for my purpose to have mentioned what is peculiar to this disease.

Of the PHAGEDENIC CARIES with HYPERSARCOSIS.

THE management of this caries is nearly the same with the former: only one or two applications of the potential caustic are sufficient to mortify some of the surface of the solid bone, which seems to reduce it to the dry caries. But I must observe, that when this caries is partial, I mean when it only seizes one part of a bone, which seldom is the case, the flesh which thrusts off the mortified squama is for most part as phagedenic or bone-consuming as what appeared at first; and therefore, even in this most favourable supposition, the surgeon should not promise a cure, unless he has corrected the habit or topical indisposition by internal remedies.

When this disease has taken firm roots, it will spread upon one end of a bone, which was in appearance sound when the cure of the other end attacked by it was begun; and it will creep along from one bone to another; with this disadvantage too, that it is far advanced before one can well discover it.

Of the SCROPHULOUS CARIES.

THE spoiled bones here being principally retained by their ligaments, which we seldom can conveniently come at to cut through, and which are too sensible to be eroded, surgeons not only lose their labour, but do considerable mischief, when, in treating such patients *secundum artem*, they forcibly keep open and dilate the orifices of ulcers where such bones are, by cramming them with hard dressings kept in by a firm bandage, and by wasting down the spongy flesh with escharotics, while they are forcibly endeavouring to make the bone come away. Such tender constitutions as these patients have, cannot bear such rough treatment; they languish and decay under it. What I have always found of most service, or rather that did the least hurt, was to destroy fully the teguments covering the abscess formed in the bone with caustic, to cut the eschar through the middle, to evacuate the collected matter, and to save the eschar on the sides as long as I could; to order very mild applications afterwards to the fore, and to wash it frequently with water for assisting the discharge of the matter; or, if the matter became fetid, to mix a little vinegar with the water. Nature at last separates the bone, which is to be taken out whenever it is quite loose.

Of the SCIRRHO-CANCROUS CARIES.

ACTUAL and potential cauteries have the same effects here as in ulcerated cancers of glands; they do not diminish the tumour, create great pain, occasion hæmorrhages when their eschars separate, &c. Most other medicines do mischief, none of them do good: extirpation alone can make a cure; which may be done either by trepanning round the root of the excrescence, cutting the bridges between the holes and bringing all away, or the member is to be amputated. All of them I have yet seen were so situated, that it was impossible to make the partial extirpation; so that I cannot say positively how it would succeed. After amputation of the member, the wound cures as well as in other diseases; but some of the patients have since been seized with the same disease in another member.

Of the SPREADING CANCROUS CRIES.

THIS sort of cancer seldom cures ; it will sometimes get a skin upon it after cutting or burning, or with gentle drying medicines or dry lint, often breaks out again unexpectedly ; in short, it is one of the *opprobria medicorum* for which there is no certain cure yet found. I never saw this disease originally formed in the bones ; they are only affected by being in the way of the disease ; so that whatever change the original disease undergoes, the bones partake of it.

Nº 8.

T H E
D E S C R I P T I O N
O F T H E

HUMAN LACTEAL SAC and DUCT.

THE *receptaculum chyli* of Pecquet, or *saccus lacteus* of Van 'Horne, is a membranous somewhat pyriform bag, two thirds of an inch long, one third of an inch over in its largest part when collapsed; situated on the first *vertebra* of the loins to the right of the *aorta*, a little higher than the right emulgent artery, behind the right inferior muscle of the diaphragm: it is formed by the union of three tubes, one from under the *aorta*, the second from the interstice of the *aorta* and *cava*, the third from under the emulgents of the right side. The *lacteal sac*, becoming gradually smaller towards its upper part, is contracted into a slender membranous pipe of about a line diameter, which is generally named the *thoracic duct*. This passes betwixt the muscular *appendices* or inferior muscles of the diaphragm, on the right of and somewhat behind the *aorta*: then, being lodged in the cellular substance behind the *pleura*, it mounts between the *aorta* and the *vena azygos* as far as the fifth *vertebra* of the *thorax*, where it is hid by the *azygos*, as this vein rises forwards to join the descending or superior *cava*; after which, the duct passes obliquely over to the left side behind the *œsophagus*, *aorta descendens*, and the great curvature of the *aorta*, until it reaches the left carotid artery; behind which, on the left side of the *œsophagus*, it runs to the interstice of the first and second *vertebra* of the *thorax*, where it begins to separate from the carotid, stretching farther towards the left internal jugular

gular vein by a circular turn, whose convex part is uppermost. At the top of this arch, it splits into two for a line and an half; the superior branch receiving into it a large lymphatic vessel from the cervical glands. This lymphatic appears, by blowing air and injecting liquors into it, to have few valves. When the two branches are again united, the duct continues its course towards the internal jugular vein, behind which it descends; and, immediately at the left side of the insertion of this vein, enters the superior posterior part of the left subclavian vein, whose internal membrane duplicated forms a semilunar valve that is convex externally, and covers two thirds of the orifice of the duct: immediately below this orifice, a cervical vein from the *musculi scaleni* enters the subclavian.

The coats of the *sac* and *duct* are thin transparent membranes: from the inside of which, in the duct, small semilunar valves are produced, most commonly in pairs; which are so situated, as to allow the passage of liquors upwards, but oppose their return in an opposite course. The number of these is generally ten or twelve.

This is the most simple and common course, situation, and structure, of the *receptaculum chyli* and *thoracic duct*; but having had occasion to observe a variety in these parts in different subjects, I shall set down the most remarkable of them.

The sac is sometimes situated lower down than in the former description; is not always of the same dimensions; is not composed of the same number of ducts; and frequently appears to consist of several small cells or ducts, instead of being one simple cavity.

The diameter of the duct is various in most bodies; and is seldom uniform in the same subject, but frequently sudden enlargements or *sacculi* of it are observable.—The divisions which authors mention of this duct are very uncertain. I have seen it divided into two; whereof one branch climbed over the forepart of the *aorta* at the eighth *vertebra* of the *thorax*, and at the fifth slipped behind that artery, to join the other branch which continued in the ordinary course.—The precise *vertebra* where it begins to turn to the left side, is also uncertain.—Frequently it does not split at its superior arch; in which case, a large sac is found near its aperture into the subclavian vein.—Generally it has but one orifice; tho'

I have seen two in one body, and three in another : nay, sometimes it divides into two, under the curvature of the great artery ; one goes to the right, another to the left subclavian vein ; and I have found this duct discharging itself entirely into the right subclavian.—The lymphatic vessel which enters its superior arch, is often sent from the *thyroid* gland.

Whether is not the situation of the *receptaculum chyli* so much nearer the muscular *appendices* of the diaphragm in men than in brutes, designed to supply the disadvantageous course the chyle must otherwise have in our erect posture ?

Does not the descent of the end of the duct to the subclavian vein, and the opening of the lymphatic into the top of the arch, contribute to the ready admission of the chyle into that vein ?

Nº 9.

H I S T O R I E S

O F T H E

CURE of LYMPHATICS opened in WOUNDS.

I Do not observe that chirurgical writers take notice of a phænomenon which I have seen several times in the cure of wounds, which possibly young surgeons may be at a loss to understand, or to know how to remedy; it is the rising of a fungous substance, from which there is a constant stillicidium of lymph, which prevents a cure, and weakens the patient if it is allowed to continue long. To assist them, I shall give two of the most remarkable examples that I have met with of such a case.

In May 1726, I extirpated a very large steatom from the left arm of a servant of Mr Graham of Killearn. It had been occasioned by a bite of a horse about twenty years before: its base reached from the middle of the deltoid muscle to near the elbow; so that the cephalic vein ran along the middle of it, and was necessarily to be cut through twice in amputating the tumour. The cure went on very successfully, the wound contracting very fast, till a yellowish white substance rose up from a small peduncle at the part where the under-part of the cephalic vein had been cut through. From this substance such a quantity of lymph oozed out from imperceptible orifices, that the dressings were every day wet. I cut and eroded this substance away several times: but it quickly grew again, and the drilling of lymph became worse and worse; so that in a very little time it dropped so fast, that I could have gathered a spoonful of it in a very short time. What cured it at last was eating the fungous stuff, and a little of the wound about, with powder of Roman vitriol, and

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dressings

dress'ing the eschar with alcohol, which kept it from separating two weeks; in which time the orifices of the small pipes were soldered.

2. A gentlewoman having been let blood of in the basilic vein in the country, soon perceived a tumour at the orifice. Several months after, she came to town. When I saw it, it was as large as a walnut, beating violently: I could make it disappear by pressure; and as I kept my thumb on it, while I yielded to the influx of the blood, I had a feeling very like to hearing the sound of water rushing into a pipe.

I tried first what pressure would do in keeping the blood from rushing into it; but that being of no use, I was obliged to perform the operation of the aneurism, which I did in the way proposed in the Medical Essays, Vol. IV. Art. xvii *. The sac, in which nothing but liquid blood was contained, was as thick and strong as the cystis of encysted tumours commonly are; and was evidently formed in the same way, that is, by the stretching and thickening of a part of the cellular membrane. However, I cut none of it away, on purpose to see what change would come on it. As the tumour had extended itself principally outwards, it had raised both median and cephalic vein in the teguments upon it; and the cephalic lay so obliquely over it, that I could not evade it in cutting.

I had the pleasure to see the hard firm bag become every day softer and thinner, with papillæ of granulated flesh growing out from it, till it became all the same soft red flesh as was in the rest of the wound.

After a fortnight, such a yellowish white fungus, with a drilling of lymph, as described in the former case, rose out from the part of the wound where the extremity of the cut vein was. I burnt it with the lunar caustic, and dressed the eschar with alcohol; which effectually cured it, and the sore was skinned fully over in some less than six weeks, and my patient enjoyed then the full use and strength of all parts of the member. The pulse at the wrist was plainly felt next day after the operation, and is now so strong that nobody could know the artery was ever tied.

The operation of the aneurism has been six times more performed here; so that in few years there are nine examples of its success in this place; all the patients who underwent it having been brought from the country:

Since 1747, the operation of the aneurism has been performed here successfully on four more patients.

Nº 10.

THE
A N A T O M Y
OF THE
H U M A N N E R V E S.

T H E
A N A T O M Y
O F T H E
H U M A N N E R V E S.

Of the NERVES in general.

1. **T**HE numerous turns which the *carotid* and *vertebral* arteries make before they pass through the *dura mater*, these arteries having neither swelling muscles nor pressure of the atmosphere to assist the course of the blood in them after they enter the skull, and their division into innumerable communicating branches in the *pia mater* and its processes, show, that the liquors must move more slowly and equally in them than in most other parts of the body.

2. By the assistance of injections and microscopes, the very minute branches of these vessels (§ 1.) are discovered to go from the *pia mater*, into the *cortex*, cineritious or ashy-coloured part of the *cerebrum*, *cerebellum*, and *spinal marrow*; whereas we can only see longitudinal vessels, without numerous ramifications or reticular plexuses, in the white medullary substance of these parts.

3. The

3. The continuity of the *cortex* with the *medulla* of the *encephalon* and *spinal marrow*, is observable with the naked eye, and is more distinctly seen with the assistance of a microscope.

4. In dissecting the *brain* and *cerebellum*, we see the small beginnings of the *medulla* proceeding from the *cortex*, and can trace its gradual increase by the addition of more such white substance coming from the *cortex*.

5. Both these substances (§ 4.) are very succulent; for, being exposed to the air to dry, they lose more of their weight than most other parts of the body do.

6. In several places, we can observe the *medulla* to be composed of fibres laid at each others sides.

7. The medullary substance is employed in forming the white fibrous cords, which have now the name of *nerves* appropriated to them. Within the skull we see the nerves to be the medullary substance continued; and the *spinal marrow* is all employed in forming nerves.

8. The common opinion concerning the rise of the nerves, founded on a superficial inspection of those parts, is, that the nerves are propagated from that side of the *encephalon* at which they go out of the skull. But it having been remarked, after a more strict inquiry, and preparing the parts by maceration in water, that the medullary fibres decussate or cross each other in some parts of the *medulla*, as for example at the *corpus annulare*, and beginning of the *spinal marrow*; and practical observers having related several examples of people whose brain was hurt on the side, while the morbid symptom, palsy, appeared on the other side of the body, of which I have seen some instances; and experiments made on brutes having confirmed these observations, it has been thought, that the nerves had their rise from that side of the *encephalon* which is opposite to their egress from the skull. It may, however, still be said, that this last opinion is not fully demonstrated, because a decussation in some parts is not a proof that it obtains universally; and if there are examples of palsy of the side opposite to where the lesion of the brain was, there are also others where the injury done to the brain and the palsy were both on the same side.

9. The

9. The nerves are composed of a great many threads lying parallel to each other, or nearly so, at their exit from the *medulla*.

This fibrous texture is evident at the origin of most of the nerves within the skull; and, in the *cauda equina* of the *spinal marrow*, we can divide them into such small threads, that a very good eye can scarce perceive them; but these threads, when looked at with a microscope, appear each to be composed of a great number of smaller threads.

10. How small one of these fibrils of the nerves is, we know not; but when we consider, that every even the most minute part of the body is sensible, and that this must depend on the nerves (which all conjoined would not make a chord of an inch diameter) being divided into branches or filaments to be dispersed through all these minute parts, we must be convinced, that the nervous fibrils are very small. From the examination of the *minimum visibile*, it is demonstrated, that each fibre in the *retina* of the eye, or expanded optic nerve, cannot exceed the size of the 32,400th part of a hair.

11. The medullary substance, of which the nervous fibrils are composed, is very tender, and would not be able to resist such forces as the nerves are exposed to within the bones, nor even the common force of the circulating fluids, were not the *pia mater* and *tunica arachnoides* continued upon them; the former giving them firmness and strength, and the latter furnishing a cellular coat to connect the threads of the nerves, to let them lie soft and moist, and to support the vessels which go with them.

It is this cellular substance that is distended when air is forced through a blow-pipe thrust into a nerve, and that makes a nerve appear all spongy after being distended with air till it dries; the proper nervous fibrils shrivelling so in drying, that they scarce can be observed.

12. These coats (§ 11.) would not make the nerves strong enough to bear the stretching and pressure they are exposed to in their course to the different parts of the body: and therefore, where the nerves go out at the holes in the *cranium* and *spine*, the *dura mater* is generally wrapt closely round them, to collect their disgregated fibres into tight firm cords; and that the tension which they may happen to be exposed to may not injure them.

them before they have got this additional coat, it is firmly fixed to the sides of the holes in the bones through which they pass.

13. The nervous cords thus composed of nervous fibrils, cellular coat, *pia* and *dura mater*, have such numerous blood-vessels, that, after their arteries only are injected, the whole cord is tinged of the colour of the injected liquor; and if the injection is pushed violently, the cellular substance of the nerves is at last distended with it.

14. A nervous cord, such as has been just now described (§ 13.) has very little elasticity, compared with several other parts of the body. When cut out of the body, it does not become observably shorter, while the blood-vessels contract three eighths of their length.

15. Nerves are generally lodged in a cellular or fatty substance; and have their course in the interstices of muscles, and other active organs, where they are guarded from pressure: but in several parts they are so placed, as if it was intended that they should there suffer the vibrating force of arteries, or the pressure of the contracting fibres of muscles.

16. The larger cords of the nerves divide into branches as they go off to the different parts; the branches being smaller than the trunk from which they come, and making generally an acute angle where they separate.

17. In several places, different nerves unite into one cord, which is commonly larger than any of the nerves which form it.

18. Several nerves, particularly those which are distributed to the bowels, after such union (§ 17.), suddenly form a hard knot considerably larger than all the nerves of which it is made. These knots were called *corpora olivaria*, and are now generally named *ganglions*.

19. The *ganglions* have thicker coats, more numerous and larger blood-vessels, than the nerves; so that they appear more red and muscular. On dissecting the *ganglions*, fibres are seen running longitudinally in their axes, and other fibres are derived from their sides in an oblique direction to the longitudinal ones.

20. Commonly numerous small nerves, which conjunctly are not equal to the size of the *ganglion*, are sent out from it, but with a structure no way different from that of other nerves.

21. The nerves sent to the organs of the senses, lose their firm coats, and terminate in a pulpy substance. The *optic nerves* are expanded into
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the soft tender webs, the *retinæ*. The *auditory nerve* has scarce the consistence of *mucus* in the *vestibulum*, *cochlea*, and *semicircular canals* of each ear. The *papillæ* of the nose, tongue, and skin, are very soft.

22. The nerves of muscles can likewise be traced till they seem to lose their coats by becoming very soft; from which, and what we observed of the sensory nerves (§ 21.), there is reason to conclude, that the muscular nerves are also pulpy at their terminations, which we cannot indeed prosecute by dissection.

23. It would seem necessary that the extremities of the nerves should continue in this soft flexible state (§ 21. 22.), in order to perform their functions right: For, in proportion as parts become rigid and firm by age, or any other cause, they lose of their sensibility, and the motions are more difficultly performed.

24. Though the fibres in a nervous cord are firmly connected, and frequently different nerves join into one trunk, or into the same *ganglion*; yet the sensation of each part of the body is so very distinct, and we have so much the power of moving the muscles separately, that if the nerves are principal agents in these two functions, which I shall endeavour to prove they are, we have reason to believe that there is no union, confusion, or immediate communication of the proper nervous fibrils, but that each fibre remains distinct from its origin to its termination.

25. Changes produced any way upon the coats of the nerves, cannot however miss to affect the nervous fibrils. The cellular substance may be too full of liquor, or may not supply enough; the liquor may not be of a due consistence, or it may be preternaturally obstructed and collected. The *pia* or *dura mater* may be too tense or too lax; their vessels may be obstructed; their proper nerves may be violently irritated, or lose their power of acting; and a great many other such changes may happen, which will not only occasion disorders in particular nerves, but may be a cause of the *sympathy* so frequently observed among the nerves; which is so necessary to be attentively regarded in a great many diseases, in order to discover their true state and nature, that without this knowledge, very dangerous mistakes in the practice of physic and surgery may be committed.

26. Many experiments and observations concur in proving, that, when

nerves are compressed, cut, or any other way destroyed, the parts served by such nerves, farther from the head or spine than where the injuring cause has been applied, have their sensations, motions, and nourishment, weakened or lost, while no such effects are seen in the parts nearer to the origin of those nerves: and in such experiments where the cause impeding the nerves to exert themselves could be removed, and the structure of the nerves not injured; as for example, when a ligature made upon a nerve, and stopping its influence, has been taken away; the motion and sensation of the parts soon were restored. From which it would appear, that the nerves are principal instruments in our sensations, motions, and nourishment; and that this influence of the nerves is not inherent in them, without the communication between these cords and their origin is preserved.

This conclusion is just, notwithstanding that sometimes, upon cutting a nerve, the effects above mentioned have been felt for a short time; but afterwards the person was sensible of no numbness or immobility: for, where-ever this is said to have happened, the cut nerve was only one of several which were sent to the member; the want of whose influence was felt no longer, than till the habit was acquired of performing the functions easily by the other nerves.

Nor is it of greater weight as an objection, that sometimes when a ligature is drawn very hard upon a nerve, and then is taken away, the nerve never again recovers its influence upon the parts it is distributed to beyond the ligature, but is of as little effect as if it had been cut through; which is to say, that its texture has been altered beyond recovery. The same thing is to be seen by tying a thread tight round a tender twig of any vegetable; it decays.

27. Experiments and observations show too, that when the parts of the *encephalon* or *spinal marrow* have been irritated, compressed, or destroyed, the parts of the body, whose nerves had their origin from such affected parts of the *encephalon* or *spinal marrow*, became convulsed, paralytic, insensible, or wasted; and in such cases where the injuring cause could be removed from the origin of the nerves, the morbid symptoms observed in the parts to which these nerves were distributed went off upon the removal of that cause. From which it is thought reasonable to conclude, that the

nerves

nerves must not only have a communication with their origin, but that the influence they have upon the parts they are distributed to, depends on the influence which they derive from the *medulla encephali* and *spinalis*.

28. Though the *spinal marrow* has its own vessels and cineritious substance which assists to form its *medulla*; yet a very large share of the medullary substance within the spine is derived from the *encephalon*, whose *medulla oblongata* descends from the head, and the influence of the *spinal marrow* on its nerves depends in a great measure on this *medulla oblongata* of the head. Hence an injury done to any part of the *spinal marrow*, immediately affects all the parts whose nerves have their origin below where the injuring cause is applied. A luxation of a *vertebra* in the loins makes the lower extremities soon paralytic; a transverse section of the *medulla* at the first *vertebra* of the neck, soon puts an end to life.

29. If such causes produce constantly such effects (§ 26. 27. 28.) in us, and other creatures living in nearly the same circumstances as we do, the conclusions already made must be good; notwithstanding examples of children and other creatures being born without *brains* or *spinal marrow*; or notwithstanding that the brains of adult creatures can be much changed in their texture by diseases; and that *tortoises*, and some other animals, continue to move a considerable time after their heads are cut off. We may be ignorant of the particular circumstances requisite or necessary to the being or well-being of this or that particular creature, and we may be unable to account for a great many phænomena: but we must believe our eyes in the examination of facts; and if we see constantly such consequences from such actions, we cannot but conclude the one to be the cause and the other the effect. It would be as unjust to deny the conclusions made in the three preceding articles because of the seemingly preternatural phænomena mentioned at the beginning of this, as it would be to deny the necessity of the circulation of the blood in us and most quadrupeds, because a frog can jump about, or a tortoise can walk long after all the bowels of its thorax and abdomen are taken out, or because the different parts of a worm crawl after it has been cut into a great many pieces. It is therefore almost universally allowed, that the nerves are *principal* instruments in our sensations, motion, and nourishment; and that the influence which they have is communicated from their origin, the *encephalon* and *medulla spinalis*. But authors are far

from agreeing about the manner in which this influence is communicated, or in what way nerves act to produce these effects.

30. Some allege, that the *nervous fibres are all solid cords acting by elasticity or vibration*; others maintain, that *those fibres are small pipes conveying liquors, by means of which their effects are produced*.

31. The gentlemen who think the nervous fibres solid raise several objections to the other doctrine, which I shall consider afterwards; and endeavour to shew the fitness of their own doctrine to account for the effects commonly observed to be produced by the nerves.

The objects of the senses plainly (say they) make impulses on the nerves of the proper organs, which must shake the nervous fibrils; and this vibration must be propagated along the whole cord to its other extremity or origin, as happens in other tense strings; and these vibrations being differently modified, according to the difference of the object and its different application, produce the different ideas we have of objects.

32. To this account of sensation, it is objected, *first*, That nerves are unfit for vibrations, because their extremities where objects are applied to them are quite soft and pappy (§ 21.), and therefore not susceptible of the vibrations supposed; and if there could be any little tremor made here by the impulse of objects, it could not be continued along the nervous cord, because the cellular substance by which each particular fibre is connected to the neighbouring ones (§ 11.), and the fatty substance in which the nervous cord is immersed (§ 15.), would soon stifle any such vibratory motion.

A *second* objection to this doctrine is, That supposing the nerves capable of vibrations by the impressions of objects, these vibrations would not answer the design. For if what we know of other vibrating strings, to wit, that their tone remains the same, unless their texture, length, or tension is altered, and that different substances striking them do no more than make the sound higher or lower; if these properties are to be applied to nerves, then it will follow, that the same nerve would constantly convey the same idea, with no other variety than of its being weaker and stronger, whatever different objects were applied to it: unless we supposed the nerve changed in its texture, length, or tension, each
time

time a different object is applied ; which, it is presumed, nobody will undertake to prove does happen.

Nay, *3dly*, If ever such a variety of vibrations could be made, our sensations would notwithstanding be confused and indistinct, because the tremulous nervous fibre being firmly connected and contiguous to several other fibres of the same cord, would necessarily shake them too, by which we should have the notion of the object as applied at all the different parts where the extremities of these fibres terminate.

33. In whatever way the favourers of the doctrine of solid nerves please to apply the elasticity of nerves to the contraction of muscles, their adversaries insist that nerves are too weak to resist such weights as the muscles sustain ; they would surely break, especially as they are in a great measure, if not wholly, deprived of their strong coats before they come to the part of the muscle they are immediately to act upon (§ 22.) The nerves being found to have little or no elasticity to shorten themselves (§ 14.), shows them altogether unfit for such an office as this of contracting muscles in the way proposed of their acting by elasticity ; and when a nerve is viewed with a microscope while the muscles it serves are in action, no contraction or motion is observed in it.—Nay, if they were elastic, they would equally exert their power of contracting muscles nearer to their origin as well as farther from it, when they were put into contraction or vibration, by irritation of any part of them. The former, however, does not happen.

34. As a further objection against either motion or sensation being owing to the elasticity of the nerves, it is said, that if this doctrine was true, the sensations would be more acute, and the contractions of muscles would be greater and stronger, when the parts become firmer and more rigid by age ; for then their elasticity is increased : Whereas, on the contrary, it appears (§ 23.) that then the sensations are blunted, and muscular contraction becomes less and weaker.

35. If the nerves were granted to be elastic, and to communicate a springy force to all the parts they are distributed to, they might appear necessary in this view to assist the application of the nutritious particles of the fluids to the sides of the vessels which these particles were to repair ; and so far might well enough account for the share which nerves are
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thought to have in nutrition : But, if we cannot make use of elasticity in the other two functions, sensation and motion, we must also endeavour to find out some other way for the nerves to act in nutrition ; which will be done afterwards.

36. Having thus stated the reasons for and against the nerves acting as solid strings, let us likewise relate the arguments for nerves being pipes, and the objections to this doctrine.

A great argument of those who think the nerves to be tubes conveying liquors, is the strong analogy of the brain and nerves to other glands of the body and their excretories, where a manifest secretion of liquor is made in the glands, to be conveyed by the excretories to the proper places in which it ought to be deposited. They think that the vascular texture of the *cortex* of the *encephalon* and *spinal marrow* (§ 2.), the continuation of the *cortex* in forming the medullary substance (§ 3. 4.), the fibrous texture (§ 6.) and succulent state of this *medulla* (§ 5.), and its being wholly employed to form the nerves (§ 7.), where the fibrous texture is evident (§ 9.); all these things, say they, conspire to show such a strong analogy between these parts and the other glands of the body, as carries a conviction that there is a liquor secreted in the *encephalon* and *spinal marrow*, to be sent out by the nerves to the different parts of the body.

37. The following objections are raised to this argument in favour of liquor conveyed in the nerves from the analogy of the glands. 1st, Other glands, it is said, have their excretories collected into a few large pipes, and not continued in such a great number of separate pipes as far as the places where the liquors are deposited ; which last must be the case, if the nerves are the excretories of the glandular brain. 2^{dly}, We see the cavities, and can examine the liquors in the excretories of other glands much smaller than the brain ; which cannot be done in the nerves. 3^{dly}, If the nerves were pipes, they would be so small, that the attraction of the liquors to their sides would prevent that celerity in the motion of the liquors, which is requisite to sensations and motions. 4^{thly}, If the nerves were pipes, they would be cylindrical ones, and consequently not subject to diseases, or at least we could have no comprehension of the diseases in them.

38. The answer to the 1st of these objections is, That there are other glands where there is a manifest secretion, and in which the disposition of the excretories is in much the same way as in the *encephalon*. The kidneys, for example, have a reticulated *cortex* of vessels, from which the *Eustachian* or *Bellinian medulla*, consisting of longitudinal fibres and a few blood-vessels in the same direction, proceeds; and this *medulla* is collected into ten, twelve, or more *papillæ*, each of which is formed of numerous small separate pipes, which singly discharge the urine into the large membranous tubes; and these united form the *pelvis*. Upon comparing this texture of the kidneys with that of the *encephalon* (§ 2. 3. 4. 5. 6. 7. 9.) the analogy will be found very strong.

39. In answer to the 2^d objection, in § 37. it is granted, that microscopes, injections, and all the other arts hitherto employed, have not shown the cavities of the nervous fibrils, or the liquors contained in them; and from what was said (§ 10.) of the smallness of the nervous fibrils, it is not to be expected that ever they should be seen. But, so long as such a number of little animals can every hour be brought to the objectors, in which they can as little demonstrate the vessels or contained fluids, it will not be allowed to be conclusive reasoning, that, because ocular demonstration cannot be given of either the tubes or their contents, therefore they do not exist. For if we have any notion of an animal, it is its being an hydraulic machine, which has liquors moving in it as long as it has life; if therefore such little animals have vessels and liquors which we cannot see, why may not some of the vessels and liquors of the human body be also invisible to us?

To avoid this answer to the objection, it is further urged, That, though we might not see the nervous tubes or the liquors they contain, as they naturally flow; yet if such liquors really exist, they ought to discover themselves, either by a nerve's swelling when it is firmly tied; or that, however subtle their fluids are, they might be collected in some drops, at least, when the cut end of a nerve of a living animal is kept some time in the exhausted receiver of an air-pump. It is affirmed, that neither did the tied nerve swell between the brain and ligature, nor was there any liquor collected in the receiver of the air-pump; from which it is concluded, that there is no liquor in the nerves.

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Some who say they have tried these experiments, affirm, that in young animals the nerve does swell above the ligature, and that a liquor does drill out upon cutting a nerve.—Whether swelling or liquor is seen or is not seen in these experiments, no conclusion for or against a nervous fluid can be made from them; for the swelling of the nerve after it is tied, or the efflux of liquors from its extremity, will never prove either to be the effect of the fluid in the proper nervous fibrils, so long as they might be occasioned by the liquors in the larger vessels of the cellular substance of the nerves; and if these same vessels of the coats of the nerves do not discover their liquors by these experiments, it is far less to be expected that the much more subtile nerves will discover theirs.

40. The 3^d objection to the doctrine of the brain being a gland, and the nerves its excretories, supposes a more rapid motion necessary in the fluid of the nerves, than what most of the defenders of the nervous fluid will now allow; and is afterwards to be considered particularly in a more proper place.

41. The 4th objection being, That if nerves are excretories of a gland, they must be cylindrical pipes, in which no obstructions or diseases would happen; but since we daily see diseases in the nerves, they must therefore not be such excretories. The answer is, That diseases happen often in the excretories of other glands, as of the liver, kidneys, &c. notwithstanding their cylindrical form, and their much shorter and less exposed course. When we consider the very tender substance of the brain, the vast complication of vessels there, the prodigious smallness of the pipes going out from it, the many moving powers which the nerves are to undergo the shock of, and the many chances which the vessels, membranes, and cellular substance accompanying the nerves, have of being disordered, and then affecting the nervous fibrils, we have very great reason to be surpris'd, that these cylindrical pipes are not much more frequently put out of order, by too great or too small a quantity of liquors; by too viscid or too thin fluids; by liquors consisting of too mild and sluggish particles, or of too acrid pungent ones; by too great or too little motion given to the liquors; by the diameters of the pipes being too much straitened, or too much enlarged; and by a great many other varieties of circumstances which might be thought capable of disturbing the functions
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of the nerves, supposing them to be cylindrical excretories of the gland, the brain.

42. The numerous vessels of the *encephalon* have brought some of the gentlemen who assert the nerves to be solid, to acknowledge, that there is a liquor secreted in the brain: but then they will not allow that this liquor is sent out by the proper nervous fibrils; but that it is poured into the cellular substance in which the nerves lie, to keep them moist and supple, and therefore fit for exerting their elasticity, vibration, &c. by which, in their opinion, the effects commonly ascribed to nerves are produced.

43. Besides the objections already mentioned (§ 32. 33.) against the nerves acting as elastic strings, this opinion has some other difficulties which may be objected to it: for instance, there is not one analogous example in the whole body of liquors secreted in a large gland, to be poured into a cellular substance, as is here supposed; the liquors in the cells of the *tela cellularis* of other parts are separated from the little arteries which are distributed to these cells.

Further, it cannot be imagined, how a liquor secreted in the *cortex* of the brain should make its way through the *medulla*, to come out into the cellular membranes on the surface of that *medulla*.

Lastly, A very simple experiment, of injecting water by the artery of any member, and thereby filling the cellular substance of the nerves of that member, shows evidently, that the liquor of the *cellular* substance of the nerves has the same fountain as the liquor has in the *tela cellularis* any where else, that is, from the little arteries dispersed upon it.

44. The doctrine of a fluid in the nerves, is not only thus supported by the analogy of the brain and nerves to the other glands and their excretories, but those who maintain this doctrine mention an experiment which they think directly proves a fluid in the nerves. It is this: After opening the thorax of a living dog, catch hold of and press one or both the *phrenic* nerves with the fingers, the *diaphragm* immediately ceases to contract: Cease to compress the nerves, and the muscle acts again. A second time, lay hold of the nerve or nerves some way above the *diaphragm*, its motion stops: Keep firm the hold of the nerve, and, with the fingers of the other hand strip it down from the fingers which make the com-

pression towards the *diaphragm*; and it again contracts. A repetition of this part of the experiment three or four times, is always attended with the same effects: but it then contracts no more, strip as you will, unless you remove the pressure, to take hold of the nerves above the place first pinched; when the muscle may again be made to contract, by stripping the nerve down towards it. This experiment I have done with the success here mentioned. Let any one try if he can imagine any other reasonable account of these appearances, than that the pressure by the fingers stopped the course of a fluid in the nerve; that so much of this fluid as remained in the nerve, betwixt the fingers and *diaphragm*, was forced into that muscle by stripping; and when it was all pressed away, the fingers above preventing a supply, the muscle contracted no more till the fingers were removed, and a fresh flow by that means was received from the spinal marrow, or from that part of the nerve which had not yet been so stripped.

It has been objected to the conclusions from this experiment, 1st, That the *diaphragm* is set in motion by stripping the nerve from, as well as towards, this muscle. And this may be well expected; for a liquor, in such small pipes, hindered to flow backwards by ligature, pinching fingers, or even the flow of their liquors from the fountain, will regurgitate forwards with velocity when pressed backwards. We see it happen in the stalks of tender succulent plants.

2^{dly}, It is said, that muscles cease to act when their veins are tied, as well as when their arteries or nerves are tied or cut; but that muscles continue to act when their veins are cut: by which it would appear, that the overloading of the vessels is an impediment to the action of muscles; and therefore the ceasing of their action, when their arteries or nerves are tied or cut, may also be owing to the liquor in the branches of these pipes of muscles stagnating when it is not propelled by the flow of more liquor from their trunks, and not to any influence or moving power, which now ceases to be conveyed to them.

It is to be observed in making the experiments just now mentioned, that the contraction of the muscles ceases soonest when the nerves, and latest when the veins, are tied.—That when veins are tied, not only are the vessels overloaded, but all the cellular substance of the muscles is filled

filled with coagulated blood; whereas when the arteries and nerves are tied, the reverse is seen, the muscles are lax and of less bulk. So that in these cases, the ceasing of the contraction of the muscles seems to depend on very different causes, to wit, a deprivation of necessary liquors in the one, and a redundancy of superfluous blood in the other. An elastic stick may be deprived of its elasticity by being made either too dry or too wet.

45. Some gentlemen, convinced of the reasonableness of the secretion of a liquor in the brain to be sent out by the nerves, but not comprehending how a fluid could have such a rapid retrograde motion as they imagined was necessary for conveying the impressions of objects made on the extremities of nerves to the *sensorium*, supposed two sorts of nerves; one that conveyed a liquor for muscular motion and nutrition; the other composed of solid nerves, that were to serve for organs of the senses, to convey the vibrations communicated from objects to the *sensorium*.

46. To this opinion (§ 45.) the objections against the sensory nerves acting by vibration (§ 32.) may be made; and there is so little reason to suspect any difference in the texture of the different parts of the brain or nerves, that, on the contrary, the structure is every where similar, and branches of the same nerve often serve both for sensation and motion.

How little necessity there is for supposing extremely rapid motions of the nervous fluid, is to be examined soon.

47. The hypothesis of great celerity in the motion of the fluid of the nerves being necessary, gave also rise to another division of the nerves into *arterious* or *effluent*, and *venous* or *refluent*. It was said, that muscular motion and nutrition depended on the arterious nerves; and that the sensations depended on an accelerated motion of the nervous fluid towards the brain, by the impressions which the objects of the senses make upon the venous nerves. By this supposition, the absurdity of rapid fluxes and refluxes in the same canal was prevented, and an advantage was thought to be gained by it, of saving too great a waste of the fluid of the nerves, which otherwise the *encephalon* and *spinal marrow* could not supply in sufficient quantity to answer all the exigencies of life.

48. To this opinion (§ 47.) it has been objected, 1st, That there is no example in the body of a secreted liquor being returned immediately and

unmixed to the gland by which it was originally separated from the mass of blood; which would be the case, were there venous nerves. *2dly*, There is no occasion for saving the fluid of the nerves in the way proposed; the organs for secreting that fluid being large enough to supply all that is necessary of it in the common functions of life.—*3dly*, If the fluid of the nerves was to be thus kept in a perpetual circulation, it would soon become too acrid for continuing with safety in such sensible tender vessels as the brain and nerves are composed of. *4thly*, This hypothesis will not answer the design for which it was proposed: For though the momentary application of an object might cause an acceleration in the fluid of venous nerves, yet if the object was kept applied to the nerves, it would stop their fluid, so that it could not go forward to the brain; and therefore, according to this doctrine, we should be sensible of no objects, except those whose application to the organs of the senses was momentary.

49. Let us now suppose it probable, that the *encephalon* and *spinal marrow* secrete a liquor from the blood which is sent into all the nerves, and that by the means of this liquor the nerves perform the offices commonly assigned to them; it is next necessary to inquire, what kind of liquor this is, and how it moves, in order to determine how well its nature and motion are fitted for performing what is expected from it.

50. The liquor of the nerves has been fancied by some to be of a very strong acid or alkaline nature: but since none of our juices appear to be of this sort, and since such liquors irritate and destroy the parts of the body which they are applied to, we cannot conceive how the brain can separate, or the nerves could bear, any thing of such an acrid nature. This tenderness and sensibility of these organs must hinder us absolutely from supposing that the liquor of the nerves can be acrid or pungent, or of the nature of spirit of wine, hartshorn, &c.

51. Some have imagined the liquor of the nerves to be capable of vast explosion like gun-powder, or of violent sudden rarefaction like air, or of strong ebullition like boiling water, or the mixture of acids with alkaline liquors. But as the mass of blood from which this fluid is derived, is not possessed of any such properties, we cannot suppose the blood to furnish what it has not in itself. Besides, all these operations are too violent
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for the brain or nerves to bear ; and when once they are begun, they are not so quickly controlled or restrained, as experience teaches us the nerves can be made to cease from acting.

52. We are not sufficiently acquainted with the properties of an *æther* or *electrical effluvia* pervading every thing, to apply them justly in the animal œconomy ; and it is as difficult to conceive how they should be retained or conducted in a long nervous cord. These are difficulties not to be surmounted.

53. The surest way of judging what kind of liquor this of the nerves must be, is to examine the liquors of similar parts of the body. All the glands separate liquors from the blood much thinner than the compound mass itself ; such is the *liquor* poured into the cavity of the *abdomen*, *thorax*, *ventricles of the brain*, the *saliva*, *pancreatic juice*, *lymph*, &c. Wherever there is occasion for secreted liquors being thick and viscid, in order to answer better the uses they are intended for, nature has provided reservoirs for them to stagnate in, where their thinner parts may be carried off by the numerous absorbent veins dispersed on the sides of those cavities, or they may exhale where they are exposed to the open air. The *mucus of the nose* becomes viscid by stagnation ; for when it is immediately secreted, it is thin and watery, as appears from the application of sternutatories, &c. The *cerumen* of the ears is of a watery consistence, when just squeezing out. The *mucus* of the alimentary canal grows thick in the *lacunæ*. The *bile* in the hepatic duct has little more consistence than lymph ; that in the gall-bladder is viscid and strong. The *urine* is much more watery as it flows from the kidneys than when it is excreted from the bladder. The *seed* is thin as it comes from the testicles, and is concocted in the *vesiculæ seminales*, &c.

54. Hence (§ 53.) we may safely conclude, that a thin liquor is secreted in the *cortex encephali* and *spinal marrow* ; and seeing the thinness of secreted liquors is generally, as the divisions of the vessels, into small subtile branches, and that the ramifications within the skull are almost infinitely subtile, the liquor secreted in the *encephalon* may be determined to be among the finest or thinnest fluids.

55. Seeing also that we can observe no large reservoir, where the liquor secreted in the *cortical substance* is deposited, to have its finer parts taken of,

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we have reason to think that it goes forward into the nerves in the same condition in which it is fecerned.

56. By fine or subtile animal-liquors, is meant no more than those which are very fluid, and which seem to consist of a large proportion of watery particles, and a lesser one of the oily, saline, and terrestrious particles. Some of the liquors which we can have in sufficient quantity to make experiments with, are so fluid, and have so little viscosity or cohesion of parts, that, when laid upon a piece of clean mirror, they evaporate without leaving a stain; such is the liquor oozing out from the surface of the *pleura*, the lymph, and several others.

If then these liquors, which are subject to our examination, the fecerning vessels of which are so large that we can see them, have such a small cohesion of parts, it might not be unreasonable to say, that the liquor of the nerves is as much more fine and fluid than lymph, as the vessels separating it are smaller; and therefore, that the fluid of the nerves is a defecated water, with a very small proportion of the other principles extremely subtilized.

57. Two experiments are said to contradict this opinion of the liquor of the nerves being so fluid and subtile. One is, that upon cutting the *cauda equina* of a living animal, a liquor as viscid as the white of an egg drops out: the other is, that a wounded nerve yields a *glairy sanies*. But these do not appear to be the proper fluid of the nerves; since it is evident, that what is discharged in both these cases, comes out of the cellular substance involving the nervous fibrils.

58. Considering how many experiments make it evident, that there is a constant uninterrupted stream of liquors flowing through all the canals of animals, which convey liquors composed of particles smaller than the diameter of their canal, which is always the case of the nerves in a natural state; it is surprising how it ever could be thought that the liquid of the nerves should be obliged to flow from the brain to each muscle the moment we will, or that this liquor should flow back with the like swiftness from the extremity of each nerve to which an object of sensation is applied. The nerves, as well as the other excretories of the glands, always are full of liquor; the degree of distension of the canals not being at all times alike even in a sound state. But this happens without inconvenience,

venience, as the sides of the canals have a power of accommodating themselves to the present quantity; unless it is very much above or below the natural standard, in both which cases diseases ensue.

59. The motion of the fluid in the nerves is therefore not only constant, but it is also equal, or nearly so: for though the blood in the larger arteries is moved unequally by the unequal forces, the contraction of the ventricle of the heart, and the weaker power, the *systole* of the arteries; yet the difference between these two moving powers comes to be less and less perceptible, as the arteries divide into smaller branches, because of the numerous resistances which the liquors meet with, and because the canals they move in become larger, till, in the very small arterious branches, there is no sensible difference in the velocity of the liquors from the effect of the heart or arteries. The motion of the fluids must still be more equal in the excretories of glands, and particularly in those where the vessels have divided into very minute branches, and the liquors have no other propelling force but the heart and arteries (see § 1.); therefore the nervous fluid moves constantly, equally, and slowly, unless when its course is altered by the influence of the mind, or by the pressure of some neighbouring active organ.

60. As there is neither proof nor probability of the *valves* supposed by some in nerves, we are not to assume them in accounting for any *phænomena*.

61. We have not, and perhaps cannot have, any idea of the manner in which mind and body act upon each other; but if we allow that the one is affected by the other, which none deny, and that the fluid of the nerves (whatever name people please to give it) is a principal instrument which the mind makes use of to influence the actions of the body, or to inform itself of the impressions made on the body, we must allow that the mind can direct this instrument differently, particularly as to quantity and celerity, though we must remain ignorant of the manner how many *phænomena*, depending on this connection of mind and body, are produced. Thus we would in vain attempt to account for animals continuing, after their heads were struck off, or their hearts were cut out, to perform actions begun before they suffered any injury.

62. Let us now suppose the nervous fluid such as has been argued for,

to wit, a very fluid saponaceous water, moving in a constant, equal, flow stream, from the *encephalon* and *spinal marrow*, in each of the proper nervous fibres, except when the motion is changed by some accessory cause, such as the mind, pressure of other parts, &c.; and let us examine how well such a supposition will agree with the *phænomena* of the three great functions, nutrition, sensation, and muscular motion, which the nerves are principal instruments of.

63. In general, we may say, that nerves can carry fluids to the most minute part of the body, to supply what is wasted in any of the solids; that the impression made by the objects of the senses on the very soft pulpy extremities of the nerves of the organs of the senses, must make such a stop in the equal-flowing nervous fluid, as must instantaneously be perceptible at the fountain-head from which the pipes affected arise; that the constant flow of the liquor of the nerves into the cavities of the *muscular fibrillæ*, occasions the natural contraction of the muscles, by the as constant *nifus* it makes to increase the transverse and to shorten the longitudinal diameter of each fibre; and that it is only to allow the mind a power of determining a greater quantity of this same fluid with a greater velocity into what muscular fibres it pleases, to account for the voluntary strong action of the muscles.

64. But, since such a superficial account would not be satisfactory, it will be expected, that the principal *phænomena* of these three functions should be explained by the means of such a fluid as has been supposed; and that the several objections against this doctrine should be answered. Let us attempt this; and, where we cannot extricate ourselves from difficulties which may be thrown in, let us honestly acknowledge ignorance.

65. A, If water, with a very small proportion of oils and salts from the earth, proves a fit nourishment for vegetables, such a liquor as the fluid of the nerves has been described (§ 56.) may not be unfit for repairing the waste in animals.

B, The slow continual motion of this nervous fluid (§ 58. 59.) to the most minute parts of the body (§ 10.), is well enough calculated to supply the particles that are constantly worn off from the solids by the circulation of the liquors and necessary actions of life.

c, The greater proportional size of the *encephalon* in young creatures
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than in adults, seems calculated for their greater proportional growth: For the younger the animal is, the larger *encephalon* and speedier growth it has.

D, A palsy and atrophy of the members generally accompanying each other, shew, that nourishment, sensation, and motion, depend on the same cause.

E, It was said (§ 26.), that the nerves were *principal* instruments in nutrition: It was not affirmed, that they were the *sole* instruments; and therefore an *atrophy* may proceed from the compression or other lesion of an artery, without being an objection to the doctrine here laid down.

66. *a.* All objects of sense, when applied to their proper organs, act by impulse; and this action is capable of being increased by increasing the impelling force. In tangible objects, that is clearly evident; the closer they are pressed to a certain degree, the more distinct perception ensues. Odorous particles need the assistance of air moved rapidly, to affect our nose: Sapid substances, that are scarce sufficient to give us an idea of their taste by their own weight, are assisted by the pressure of the tongue upon the palate: The rays of light collected drive light bodies before them: Sound communicates a vibration to all bodies in harmonic proportion with it.

The impulses made thus by any of these objects on the soft pulpy nerves (§ 21.), which are full of liquor, presses their sides or extremities, and their liquor is hindered from flowing so freely as it did. The canals being all full (§ 58.) this resistance must instantaneously affect the whole column of fluids in the canals that are pressed, and their origins, and have the same effect as if the impulse had been made upon the origin itself. To illustrate this by a gross comparison: Let any one push water out of a syringe, through a long flexible pipe fixed to the syringe, and he is sensible of resistance or a push backwards, the moment any one stops the orifice of the pipe, or closes the sides of it with his fingers. This impulse made on the nerves, and thus communicated to their origin, varies according to the strength or weakness, the quickness or slowness, the continuation or speedy removal, the uniformity or irregularity, the constancy or alternation, &c. with which objects are applied to the nerves.

b. Whenever any object is regularly applied with due force to a nerve,

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rightly disposed to be impressed by it, and is communicated, as just now explained, to the *sensorium*, it gives a true and just idea of the object to the mind.

c. The various kinds of impulses which the different classes of objects make, occasion in animals, which ought to have accurate perceptions of each object, a necessity of having the different organs of the senses variously modified, so that the several impulses may be regularly applied to the nerves in each organ ; or, in other words, we must have different organs of the senses fitted to the different classes of objects.

d. As the objects have one common property of impulse, so all the organs have most of the properties of the organ of touching in common with the *papillæ* of the skin. In the nose and tongue, this is evident : In some operations of the eyes we can also perceive this ; as we may likewise do in some cases where matter is collected in the internal ear.

e. These properties common to the different objects and organs, occasion frequently uncommon effects in the application of an object to an organ proper to another object of sensation. For sometimes we have the same idea as if the object had been applied to its own proper organ. At other times the object is as it were changed, and we have the idea as if the organ had had its own proper object applied to it. Thus, for example, light is the proper object to be applied to the eye, to give us any idea of colours ; yet when all light is excluded from the eyes, an idea of light and colours may be excited in us by coughing, sneezing, rubbing, or striking the eye-ball.—A cane vibrating, so as not to excite sound perceptible to the ear, applied to the teeth, raises a strong idea of sound ; as a little insect creeping in the *meatus auditorius* also does.—The fingers applied to two rough surfaces, rubbing on each other, are sensible of the sound they make ; surgeons of any practice in the cure of fractured bones can bear witness to the truth of this.—The fingers dipped in acid and several other acrid liquors, have a sensation very like to tasting.—Smelling and tasting, every body knows, are subservient and assisting to each other. From such examples, we have further proof of one general cause of our sensations, to wit, impulse from the objects ; and of such a similarity and relation in the organs, as might give reason for imagining that any one of them would be capable of producing the effect of another,

another, if the impulses of the different objects could be regularly applied to each.—Hence light and sound may affect insects and other animals that have not eyes or ears.

f. If the impulse of an object is applied with due force, but irregularly, a confused idea of the object is raised. Distant objects are confused to *myopes*, as very near ones are to *presbytae*.

g. If the application of the impulse is regular, but the force with which it is applied is too weak, our perception of the object is too faint. One may whisper so low as not to be heard.

h. If the application of objects is too violent, and there is any danger of the tender organs of our senses being hurt or destroyed, an uneasy sensation we call *pain* is raised, whatever the organ thus injured is. The object of feeling affects every organ: Thus pressure, stretching, cutting, pricking, acrid salts, pungent oils, great heat, violent cold, &c. occasion pain, wherever they are applied. Besides, every particular organ can be affected with pain by the too violent application of its own proper object. Too much light pains the eyes; very loud sound stuns the ears; very odorous bodies and too rapid objects hurt the nose and tongue. A pretty proof this, that the objects of our senses all act, and that the organs are all impressed, in nearly the same way.

i. Since a middle impulse, neither too small nor too great, is necessary for a clear perception of objects, we would often be in danger of not distinguishing them, if we were not subjected to another law, to wit, that numerous impulses made at once, or in a quick succession to each other, increase our perceptions of objects. Thus, such sound as would not be heard on a mountain-top, will be distinctly heard in a wainscotted chamber.—We feel much more clearly a tangible object when our finger is drawn along it, than when applied with the same force, but by a single pressure upon it.—We make repeated applications of odorous and rapid objects, when we wish to smell or taste accurately.—The end of a burning stick appears much more luminous when quickly whirled in a circle than when at rest.

k. Whenever the uneasy sensation, *pain*, is raised by the too strong application of objects, a sort of necessity is as it were imposed upon the mind to endeavour to get free of the injuring cause, by either withdrawing

ing the grieved part of the body from it, as one retires his hand when his finger is pricked or burnt; or the injuring cause is endeavoured to be forced from the body, as a *teneismus* excites the contraction which pushes acrid *faces* out of the *rectum*. In both these operations, a convulsive contraction is immediately made in the lesed part, or in the neighbourhood of it; and if the irritation is very strong or permanent, the greater part of the nervous system becomes affected in that spasmodic or convulsive way.—Is it this necessity which obliges the mind to exert herself in respiration, or in the action of the heart, when the lungs or heart are gorged with blood? or the *iris* to contract the pupil, when the eye is exposed to strong light? or sneezing to be performed when the nose is tickled? &c.—Will not a *stimulus* of any nerve more readily affect those with which it is any where connected than the other nerves of the body? —May not this sympathy serve as a monitor of the mind, rather to employ the organs furnished with nerves thus connected, to assist in freeing her of any uneasy sensation, than to make use of any other organs? —Will not this in some measure account for many salutary operations performed in the body, before experience has taught us the functions of the organs performing them.

This *nifus* of the mind to free the body from what is in danger of being hurtful, may serve to explain the phenomena of a great many diseases, when we are acquainted with the distribution of the particular nerves: and from this we can understand the operation of medicines that stimulate; and may learn how, by exciting a sharp, but momentary pain, we may free the body from another pain that would be more durable; and that, by having it thus in our power to determine a flow of the liquor of the nerves to any particular part, for the benefit of that part, or the relief of any other diseased part, we can do considerable service by a right application of the proper medicines.

1. If a pain-giving cause is very violent or long continued, it destroys the organs either irrecoverably, or puts them so much out of order that they only gradually recover: People have been made blind or deaf for all their lives after a violent effect of light on their eyes, or of sound on their ears; and we are frequently exposed to as much light and sound as to make us unfit to see or hear for a considerable time. I would explain
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this by a ligature put round the tender branch of an herb. This ligature, drawn to a certain degree, may weaken the canals so as to be unfit for the circulation of the juices a good while, till they are gradually explicated and made firm by these juices: A stricter ligature would disorder the structure of the fibres so much, that the liquors could not recover them. The analogy is so plain, that it needs no commentary.—Thus, the influence of a nerve tied with an artery in the operation of an aneurism, may cease for some time, but be afterwards recovered.

67. 1. In applying the fluid of the nerves to the action of muscles, it was said, that the natural or involuntary contraction of muscles was the *nifus* which the nervous fluid flowing constantly into the muscular fibres makes to distend these fibrils, by enlarging their transverse diameters and shortening their axes; and that voluntary action was owing to a greater quantity of that nervous liquor determined towards the muscle to be put in action, and poured with greater *momentum* into the muscular fibrils, by the power of the mind willing to make such a muscle to act, or obliged to do it by an irritating pain-giving cause (§ 66. k.).

2. Some object to this account of muscular motion, that, if there is no outlet for the liquor supposed to be poured into muscular fibres, muscles would always be in a state of contraction, which they are not; and if there is a passage from the fibrils, the liquor would flow out as fast as it was thrown in; and therefore no distension of the fibres or contraction of the muscles could be made.

3. In answer to this objection, it is observed, that, notwithstanding the evident outlet from the arteries into the veins, yet the arteries are distended by the *systole* of the heart, or any other cause increasing the *momentum* of the blood.

4. It has been also objected to § 1. that, if it was true, the volume of the muscle in contraction necessarily would be considerably increased by so much liquor poured into its fibrils; whereas it does not appear, by any experiment, that the volume of a muscle is increased by its being put into action.

5. To this it has been answered, (1.) That, when the axes of muscular fibres are shortened, and their transverse diameters are enlarged, the capacities of their fibres, and consequently their volume, may not be changed,

ed, the diminution one way balancing the increase in the other. (2.) That the spaces between the muscular fibres are sufficient to lodge these fibres when they swell, during the contraction of a muscle, without any addition to its bulk; and that it plainly appears that these spaces between the fibrils are thus occupied, by the compression which the larger vessels of muscles, which run in those spaces, suffer during the action of the muscle; it is so great as to drive the blood in the veins with a remarkable accelerated velocity.

6. Another objection to the action of muscles being owing to the influx of a fluid into their fibrils is, That muscular fibres are distractile, or capable of being stretched: and therefore, when a fluid is poured into their hollow fibrils, they would be stretched longitudinally, as well as have their transverse diameters increased; that is, a muscle would become longer, as well as thicker, when it is put into action; whereas it is certainly known, that a muscle is shortened while it acts.

7. In answer to this, it has been remarked, That, though muscular fibrils are distractile, yet they will not yield to, or be stretched by, every force, however small, that might be applied to them. A cord that can be stretched in length by the weight of a pound or two, would not yield in the least to an ounce or two; and it must likewise be observed, that, gradually as any body is stretched, its resistance to the stretching force increases. A rope may be stretched to a certain length by a pound weight appended to it, which would require two pounds to stretch it very little further: and therefore the general observation of animal-fibres being distractile cannot be a reasonable objection to the account of muscular motion above mentioned, unless a proof is brought that the force which the liquid of the nerves must exert upon each fibre of a muscle, in order to make it act, is capable of distracting or stretching the fibres; which has not yet been attempted to be proved.—It would appear from the pain caused by too great an effort of the muscles, especially in weak people, that muscular fibres can bear very little distraction without danger of a solution of continuity.

8. Muscles ceasing to act when their arteries are tied or cut, and being brought into motion by injecting liquors into the arteries even of a dead animal, has been mentioned as objections to the nervous influence causing their contractions.

To the first of these experiments, it may be answered, That the tying or cutting of the nerves sooner produces the effect of making the contraction cease, than stopping the influx of the arterious blood does; and it will be universally allowed, that the influx of blood into muscles is necessary for performing their functions right.

Whoever observes the motion which injecting water, or any other liquor, into the arteries of a dead animal, causes in its muscles, will not compare it to what contraction, whether voluntary or excited by irritation, he may see in a living one.

9. If muscular motion depends on the influx of the nervous liquid, the instantaneous contraction of a muscle, when the mind wills to make it act, will be easily understood from the nerves being always full of their liquor (§ 58. 66. a).

10. If either the nerves of any muscle do not furnish a sufficient quantity of their liquor, or if the fibres of a muscle become too easily distrac-tile, such a muscle will be unactive or paralytic.

11. If too great a quantity of the liquor of the nerves is determined to a muscle or muscles, by any cause which the mind cannot command, such muscle or muscles will be convulsed.

12. If the motion of the liquid of the nerves is not uniform, but by disease becomes irregular, an alternate relaxation and contraction of muscles may be the consequence. Hence trembling palsies, *chorea Sancti Viti*, &c. Hence also the convulsive tremors which animals have when they lose much blood.

13. Though the nerves may not furnish so much liquor as may be sufficient to make muscles contract with strength enough to overcome the resistances to their actions; yet there may be a sufficient quantity of liquor in the nerves to allow the impressions of objects to be conveyed to the *sensorium*. This may be one cause of a member's being sometimes sensible after it cannot be moved.

14. Unless the liquor of the nerves acquires some energy in the brain, which we have no reason to think the circulation of the fluids in the vessels can give it, or unless it has other properties than what we can discover in it, or unless there is an agent regulating its *momentum* and course to different parts which we are not conscious of; if some of these, I say,
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do not obtain, the action of the heart continuing of equal force to propel our liquors, notwithstanding all the resistances that are to it, is not to be explained.

15. All muscles, but especially the heart, continue to contract in an irregular way, after they are cut away from the animal to whom they belonged; which may be owing to the liquors continuing to flow in the small vessels, and being poured irregularly into the muscular *fibrillæ*.

16. It is said, that a muscle cut out of the body continues some time to be capable of contraction; whereas, by tying its arteries or nerves, while it is otherwise entire in the body, it loses its contracting power; which therefore does not depend on these organs, the arteries or nerves.

The loss of the power of acting when the arteries or nerves are tied while the muscle is in the body, is denied by some who made the trial; and it might be expected, that the motion of a muscle would be more conspicuous where there is no resistance to it, as is the case when it is cut away from all the parts it is connected with, than when its connection remains with parts resisting its contractile efforts.

17. After the heart, or any other muscle cut away from an animal, has ceased to contract, its contraction may again be restored, by breathing upon it, or pricking it with any sharp instrument. That heat or pricking should, by their *stimulus* (§ 66. *k*), occasion contraction in a living creature, may be understood; but how they should have the same effect in a muscle separated from an animal, I know not.

68. Some have thought the *ganglions* of nerves (§ 18. 19. 20.) to be glandular, and to perform a secretion.—Others, from their firm texture, suppose them to be muscular, and to serve to accelerate the motion of the liquor in the nerves which proceed from them; but as no proof is offered of either of these opinions, they cannot be maintained.—Others would make them serve, 1. To divide a small nerve into many nerves; and by these means to increase the number of nervous branches: 2. To make nerves come conveniently by different directions to the parts to which they belong: 3. To reunite several small nervous fibres into one large nerve.—Since no proof is brought that these three things cannot be done without the interposition of a *ganglion*, but, on the contrary, we see them performed where there are no *ganglions*, we must continue to acknowledge

acknowledge ignorance concerning the uses of these knots, the *ganglions*.

Of the PARTICULAR NERVES.

IT is generally said, that there are forty pair of nerves in all; of which ten come out from the *encephalon*, and the other thirty have their origin from the *spinal marrow*.

Of the ten pair of nerves which come from the *encephalon*, the first is the OLFACTORY, which long had the name of the *mamillary processes* of the brain; because in the brutes, cows and sheep, which were most commonly dissected by the ancients, the anterior ventricles of the brain are extended forwards upon these nerves, and adhere so firmly to them, that they seem to make the upper side of the nerves. Each of them being large where it begins to be stretched out, and gradually becoming smaller as it approaches the cribriform bone, was imagined to resemble a nipple. Those who mistook the ventricles for part of the nerves, observing the cavity in them full of liquor, concluded, that these olfactory nerves served to convey the superfluous moisture of the brain to the holes of the ethmoid bone through which it passed into the nose. But in man, the ventricles of whose brain are not thus extended forwards, these nerves are small, long, and without any cavity, having their origin from the *corpora striata*, near the part where the internal carotid arteries are about to send off their branches to the different parts of the brain; and in their course under the anterior lobes of the brain, which have each a depression made for lodging them, the human olfactory nerves become larger till they are extended to the cribriform bone, where they split into a great number of small filaments, to pass through the little holes in that bone; and being joined by a branch of the fifth pair of nerves, are spread on the membrane of the nose.

The tender structure and sudden expansion of these nerves on such a large surface, render it impossible to trace them far; which has made some authors deny them to be nerves: but when we break the circumference of the *cribiform lamella*, and then gently raise it, we may see the distribution of the nerves some way on the membrane of the nose.

The contrivance of defending these long soft nerves from being too much pressed by the anterior lobes of the brain under which they lie, is singular; because they have not only the prominent orbital processes of the frontal bone to support the brain on each side, with the veins going into the longitudinal *sinus*, and other attachments bearing it up, but there is a groove formed in each lobe of the brain itself for them to lodge in.—Their splitting into so many small branches before they enter the bones of the skull, is likewise peculiar to them; for generally the nerves come from the brain in disgregated filaments, and unite into cords, as they are going out at the holes of the bones. This contrivance is the best for answering the purpose they are designed for, of being the organ of smelling; for had they been expanded upon the membrane of the nose into a medullary web, such as the optic nerve forms, it would have been too sensible to bear the impressions of such objects as are applied to the nose; and a distribution in the more common way, of a cord sending off branches, would not have been equal enough for such an organ of sensation.

The second pair of nerves, the OPTIC, rising from the *thalami nervorum optitorum*, make a large curve outwards, and then run obliquely inwards and forwards, till they unite at the fore-part of the *sella turcica*; then soon divide, and each runs obliquely forwards and outwards to go out at its proper hole in the sphenoid bone, accompanied with the ocular artery, to be extended to the globe of the eye, within which each is expanded into a very fine cup-like web, that lines all the inside of the eye as far forwards as the *ciliary circle*, and is universally known by the name of *retina*.

Though the substance of this pair of nerves seems to be blended at the place where they are joined; yet observations of people whose optic nerves were not joined, and of others who were blind of one eye from a fault in the optic nerve, or in those who had one of their eyes taken out, make it appear, that there is no such intimate union of substance; the optic nerve of the affected side only being wasted, while the other was large and plump. And the same observations are contradictory to the doctrine of a decussation of all the nerves (§ 8.); for the disease could be traced from the affected eye to the origin of the nerve on the same side.

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In many fishes, indeed, the doctrine of decussation is favoured; for their optic nerves plainly cross each other, without any union at the part where they are joined in men and most quadrupeds.

Those people whose optic nerves were not joined, having neither seen objects double, nor turned their eyes different ways, is also a plain proof, that the conjunction of the optic nerves will not serve to account for either the uniform motions of our eyes, or our seeing objects single with two eyes, though it may be one cause of the remarkable sympathy of the one eye with the other in many diseases.

The *retina* of a recent eye, without any preparation, appears a very fine web, with some blood-vessels coming from its centre to be distributed on it; but after a good injection of the arteries that run in the substance of this nerve, as is common to other nerves, it is with difficulty that we can observe its nervous medullary substance.—The situation of these vessels in the central part of the optic nerve, the want of medullary fibres here, and the firmness of this nerve before it is expanded at its entry into the ball of the eye, may be the reason why we do not see such bodies, or parts of bodies, whose picture falls on this central part of the *retina*.—An inflammation in those arteries of the *retina*, which several fevers and an *ophthalmia* are generally attended with, may very well account for the tenderness in the eyes, and inability to bear the light, which people have in these diseases.—The over-distension of these vessels may likewise serve to account for the black spots observed on bright-coloured bodies especially, and for that smoky fog through which all objects are seen by people in some fevers.—If these vessels lose their tone, and remain preternaturally distended, no objects affect our *retina*, though the eye externally appears sound; or this may be one cause of an *amaurosis* or *gutta serena*.—From a partial distension of these vessels, or *paralysis* of a part of the *retina*, the central part, or the circumference, or any other part of objects, may be lost to one or both eyes.

The THIRD PAIR rise from the anterior part of the *processus annularis*; and, piercing the *dura mater* a little before, and to a side of the ends of the posterior clinoid process of the sphenoid bone, run along the *receptacula*, or *cavernous sinuses*, at the side of the *ephippium*, to get out at the *foramina lacera*: after which each of them divides into branches; of which one,

after forming a little *ganglion*, is distributed to the globe of the eye; the others are sent to the *musculus rectus* of the *palpebra*, and to the *attollens*, *adductor*, *deprimens*, and *obliquus minor* muscles of the eye-ball. These muscles being principal instruments in the motions of the eye-lid and eye-ball, this nerve has therefore got the name of the *motor oculi*.—I have frequently observed in convulsions the eye-lids widely opened, the *cornea* turned upward and outwards, and the eye-balls sunk in the orbit; which well described the conjunct action of the muscles which this pair of nerves serves.—The distension of a considerable branch of the carotid, which passes over this nerve near its origin on each side, may possibly be the reason of the heaviness in the eye-lids and eyes, after drinking hard, or eating much.

The FOURTH PAIR, which are the smallest nerves of any, derive their origin from the back-part of the base of the *testes*; and then making a long course on the side of the annular protuberance, enter the *dura mater* a little farther back and more externally than the third pair, to run also along the *receptacula*, to pass out at the *foramina lacera*, and to be entirely spent on the *musculi trochleares*, or superior oblique muscles of the eyes. These muscles being employed in performing the rotatory motions, and the advancement of the eye-balls forward, by which several of our passions are expressed, the nerves that serve them have got the name of *PATHE-TICI*.—Why these small nerves should be brought so far to this muscle, when it could have been supplied easily by the *motor oculi*, I know not.

The FIFTH PAIR are large nerves, rising from the annular processes, where the medullary processes of the *cerebellum* join in the formation of that *tuber*, to enter the *dura mater* near the point of the petrous process of the temporal bones; and then sinking close by the *receptacula* at the sides of the *fella turcica*, each becomes in appearance thicker, and goes out of the skull in three great branches.

The first branch of the fifth is the *OPHTHALMIC*, which runs through the *foramen lacerum* to the orbit, having in its passage thither a connection with the sixth pair. It is afterwards distributed to the ball of the eye with the third; to the nose, along with the olfactory, which the branch of the fifth that passes through the *foramen orbitarium internum* joins, as was already mentioned in the description of the first pair. This ophthalmic

mic branch likewise supplies the parts at the internal *canthus* of the orbit, the *glandula lacrymalis*, fat, membranes, muscles, and teguments of the eye-lids; its longest farthest extended branch passing through the *foramen superciliare* of the *os frontis*, to be distributed to the fore-head.

The small fibres which this first branch of the fifth and the third pair of nerves send to the eye-ball, being situated on the optic nerve; and, after piercing the sclerotic coat, running along the choroid coat on the outside of the *retina* in their course to the *uvea* or *iris*, may be a cause of the sympathy between the optic nerve and the *uvea*; by which we more readily acquire the habit of contracting the *iris*, and thereby lessen the pupil, when too strong light is excluded; and, on the contrary, enlarge the pupil, when the light is too faint.—This, with the sympathy which must arise from some of the nerves of the membrane of the nostrils being derived from this first branch of the fifth pair of nerves, may also be the cause why an irritation of the *retina*, by too strong light, may produce sneezing, as if a *stimulus* had been applied to the membrane of the nose itself;—why pressing the internal *canthus* of the orbit, sometimes stops sneezing;—why irritation of the nose or of the eye causes the eye-lids to shut convulsively, and makes the tears to flow plentifully;—and why medicines put into the nose do often great service in diseases of the eyes.—In the megrim, all the branches of the nerve discover themselves to be affected: for the forehead is racked with pain; the eye-ball is pained, and feels as if it was squeezed; the eye-lids shut convulsively, the tears trickle down, and an uneasy heat is felt in the nose. Hence we can understand where external medicines will have the best effect when applied to remove this disease, to wit, to the membrane of the nose, and to the forehead;—why alternate pressure near the superciliary hole of the frontal bone, or sneezing, sometimes gives immediate relief in the megrim;—why the sight may be lost by an injury done to the *supra orbital* branch;—how it may be restored by agitation of that branch of this nerve.

The second branch of the fifth pair of nerves may be called MAXILLARIS SUPERIOR, from its serving principally the parts of the upper jaw: It goes out at the round hole of the sphenoid bone, and sends immediately one branch into the channel on the top of the *antrum maxillare*; the membrane

brane of which, and the upper teeth, are supplied by it in its passage. As this branch is about to go out at the *foramen orbitarium externum*, it sends a nerve through the substance of the *os maxillare* to come out at *Steno's* duct, to be distributed to the fore-part of the palate; and what remains of it escaping at the *external orbital* hole, divides into a great many branches, that supply the cheek, upper lip, and nostril.—The next considerable branch of the *superior maxillary* nerve, after giving branches which are reflected through the sixth hole of the sphenoid bone, to join the intercostal where it is passing through the skull with the carotid artery, and the *portia dura* of the seventh pair as it passes through the *os petrojum*, is sent into the nose by the hole common to the palate and sphenoidal bone; and the remaining part of this nerve runs in the *palato-maxillaris* canal, giving off branches to the temples and pterygoid muscles, and comes at last into the palate to be lost.—Hence the ach in the teeth of the upper jaw occasions a gnawing pain deep seated in the bones of the face, with swelling in the eye-lids, cheek, nose, and upper lip; and, on the other hand, an inflammation in these parts, or a megrim, is often attended with sharp pain in the teeth.—Hence an obstruction in the duct of the maxillary sinus, which obliges the liquor secreted there to find out a preternatural route for itself, may be occasioned by the pain of the teeth.—Hence the upper lip often suffers when the palate or nose is ulcerated.

The third or MAXILLARIS INFERIOR branch of the fifth pair going out at the oval hole of the sphenoid bone, serves the muscles of the lower jaw, and the muscles situated between the *os hyoides* and *jaw*: all the salivary glands, the *amygdalæ*, and the external ear, have branches from it: it has a large branch lost in the tongue; and sends another through the canal in the substance of the lower jaw to serve all the teeth there, and to come out at the hole in the fore-part of the jaw, to be lost in the chin and under lip. Hence a convulsive contraction of the muscles of the lower jaw, or the mouth's being involuntarily shut, a great flow of spittle or salivation, a pain in the ear, especially in deglutition, and a swelling all about the throat, are natural consequences of a violent irritation of the nerves of the lower teeth in the toothach; and pain in the teeth and ear is as natural a consequence of an *angina*.—Hence alternate pressure on the chin may
sometimes

sometimes relieve the violence of a toothach.—Hence destroying the nerves of a tooth by actual or potential cauteries, or pulling a carious tooth, so often removes immediately all these symptoms.—Hence no cure is to be found for some ulcers in the upper or lower jaw, but by drawing a tooth.—Hence, in cancers of the upper lip, the salivary glands are in danger of being affected, or the disease may be occasioned to the lip by its beginning in the glands.—Perhaps the sympathy of the organs of tasting and smelling may in some measure depend on their both receiving nerves from the fifth pair.

The SIXTH PAIR, which is the smallest except the fourth, rises from the fore-part of the *corpora pyramidalia*; and each entering the *dura mater* some way behind the posterior clinoid process of the sphenoid bone, has a long course below that membrane, and within the *receptaculum* at the side of the *fella turcica*, where it is immersed in the blood of the receptacle, but for what purpose I am ignorant. It goes afterwards out at the *foramen lacerum* into the orbit, to serve the abductor muscle of the eye.—A defect in this nerve may therefore be one cause of a *strabismus*. In the passage of this nerve below the *dura mater*, it lies very contiguous to the internal carotid artery, and to the ophthalmic branch of the fifth pair of nerves. At the place where the sixth pair is contiguous to the carotid, a nerve either goes from each of them in an uncommon way, to wit, with the angle beyond where it rises obtuse, to descend with the artery, and to form the beginning of the intercostal nerve, according to the common description; or, according to other authors, this nerve comes up from the great ganglion of the *intercostal*, to be joined to the sixth here.

The arguments for this latter opinion are, That, according to the common doctrine, this beginning of the *intercostal* nerve, as it is called, would rise in a manner not so ordinary in nerves. In the next place, it is observed, that the sixth pair is larger nearer to the orbit, than it is before it comes to the place where this nerve is said to go off; and therefore it is more probable, that it receives an addition there, rather than gives off a branch. Lastly, it is found, that, upon cutting the *intercostal* nerves of living animals, the eyes plainly were affected; they lost their bright water; the gum, or gore, as we call it, was separated in greater quantity; the pupil was more contracted; the cartilaginous membrane, at the internal

ternal *canthus*, came more over the eye ; and the eye-ball itself was diminished.

To this it is answered, in defence of the more common doctrine, 1st, That other branches of nerves go off in a reflected way, as well as this does, supposing it to be the beginning of the intercostal ; and that the reflection would rather be greater, if it is thought to come up from the intercostal to the sixth. 2^{dly}, It is denied that this nerve is for ordinary thicker at its fore than its back part ; and, if it was supposed to be thickest nearer to the orbit, the conclusion made above could not be drawn from this appearance, because other nerves enlarge sometimes where there is no addition made to them, as in the instance already mentioned of the trunk of the fifth pair while below the *dura mater*. 3^{dly}, The experiments on living animals shew, indeed, that the eyes are affected upon cutting the intercostal nerve ; but not in the way which might have been expected, if the *intercostal* had furnished such a share of the nerve that goes to the *abductor* muscle of the eye : for it might have been thought, that this muscle would have been so much weakened immediately upon cutting the *intercostal*, that its antagonist the *adductor* would have greatly prevailed over it, and have turned the eye strongly in towards the nose ; which is not said to be a consequence of this experiment. So that the arguments are still equivocal ; and more observations and experiments must be made, before it can be determined, with certainty, whether the sixth pair gives or receives a branch here. In the mean time, I shall continue to speak about the origin of the *intercostal*, with the generality of anatomists.

At this place where the intercostal begins, the fifth pair is contiguous and adherent to the sixth ; and it is generally said, that the ophthalmic branch of the fifth gives a branch or two to the beginning of the intercostal, or receives such from it. Others deny any such communication between them ; and those who affirm the communication confess, that in some subjects they could not see it. After examining the nerves here in a great many subjects, I cannot determine whether or not there are nervous filaments going from the one to the other. Sometimes I have thought that I traced them evidently ; at other times I observed, that what I dissected for nervous filaments, was collapsed cellular substance ; and, in all the subjects where I had pushed an injection successfully into the very
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small arteries, I could only observe a *plexus* of vessels connecting the one to the other. In any of these ways, however, there is as much connection as, we are assured from many experiments and observations on other nerves, is sufficient to make a very great sympathy among the nerves here. Possibly the appearances in the eyes of dogs, whose intercostal nerves were cut, might be owing to this sympathy.

The SEVENTH PAIR comes out from the lateral part of the *annular process*, behind where the medullary processes of the *cerebellum* are joined to that *tuber*; and each being accompanied with a larger artery than most other nerves, enters the *internal meatus auditorius*, where the two large bundles of fibres, of which it appeared to consist within the skull, soon separate from each other: one of them entering by several small holes into the *vestibule*, *coclea*, and *semicircular canals*, is stretched on this inner *camera* of the ear in a very soft pulpy substance; and, being never seen in the form of a firm cord, such as the other parcel of this and most other nerves become, is called PORTIO MOLLIS of the auditory nerve.

The other part of this seventh pair passes through *Galen's foramen cecum*, or *Fallopian's aquæduct*, in its crooked passage by the side of the *tympanum*; in which passage, a nerve sent from the lingual branch of the inferior maxillary nerve, along the outside of the *tuba Eustachiana*, and crosses the cavity of the *tympanum*, where it has the name of *chorda tympani*, is commonly said to be joined to it. The very acute angle which this nerve makes with the fifth, or the sudden violent reflection it would suffer on the supposition of its coming from the fifth to the seventh, appears unusual; whereas, if we suppose that it comes from the seventh to the fifth, its course would be more in the ordinary way, and the *chorda tympani* would be esteemed a branch of the seventh pair going to join the fifth, the size of which is increased by this acquisition. This smaller bundle of the seventh gives branches to the muscles of the *malleus*, and to the *dura mater*, while it passes through the bony crooked canal, and at last comes out in a firm chord named PORTIO DURA, at the end of this canal, between the *styloid* and *mastoid* processes of the temporal bone, giving immediately filaments to the little oblique muscles of the head and to those that rise from the styloid process. It then pierces through the parotid gland; and divides into a great many branches, which are dispersed in

the muscles and teguments that cover all the side of the upper part of the neck, the whole face and *cranium*, as far back as the temples, including a considerable part of the external ear. Its branches having thus a considerable connection with all the three branches of the fifth pair, and with the second cervical, occasion a considerable sympathy of these nerves with it.—Hence, in the toothach, the pain is sometimes very little in the affected tooth, compared to what it is all along the side of the head and in the ear.—Hence probably the relief of the toothach from blisters applied behind or before the ear, or by a hot iron touching the *antibelix* of the ear.—By this communication or connection possibly too it is, that a vibrating string held between one's teeth, gives a strong idea of sound to the person who holds it, which nobody else can perceive.—Perhaps too the distribution of this nerve occasions the head to be so quickly turned upon the impression of sound on our ears.

The EIGHTH PAIR of nerves rise from the lateral bases of the *corpora olivaria* in disgregated fibres; and, as they are entering the anterior internal part of the holes common to the *os occipitis* and *temporum*, each is joined by a nerve which ascends within the *dura mater* from the tenth of the head, the first, second, and inferior cervical nerves: This every body knows has the name of the NERVUS ACCESSORIUS. When the two get out of the skull, the *accessorius* separates from the eighth, and, descending obliquely outwards, passes through the *sterno-mastoideus* muscle, to which it gives branches, and afterwards terminates in the *trapezius* and *rhomboid* muscles of the *scapula*. In this course it is generally more or less joined by the second cervical nerve.—Why this nerve, and several others which are distributed to muscles, are made to pierce through muscles, which they might have only passed near to, I do not know.

The large *eighth pair*, soon after its exit, gives nerves to the tongue, *larynx*, *pharynx*, and *ganglion* of the *intercostal* nerve, and, being disjoined from the ninth and intercostal, to which it adheres closely some way, runs straight down the neck behind the internal jugular vein, and at the external side of the carotid artery. As it is about to enter the *thorax*, a large nerve goes off from the eighth of each side: This branch of the right-side turns round from the fore to the back part of the subclavian artery, while the branch of the left-side turns round the great curve of the

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the *aorta*, and both of them mounting up again at the side of the *æsofphagus*, to which they give branches, are lost at last in the *larynx*. These are called the RECURRENT nerves, which we are desired to shun in the operation of *bronchotomy*, though their deep situation protects them sufficiently.—The muscles of the *larynx* being in a good measure supplied with nerves from the recurrents, it is to be expected, that the cutting of them will greatly weaken the voice, though it will not be entirely lost, so long as the superior branches of the eighth pair are entire.—Why the recurrent nerves rise so low from the eighth pair to go round a large artery, and to have such a long course upwards, I know not.

The eighth pair, above and at or near the place where the recurrent nerves go off from it, or frequently the recurrents themselves, send off small nerves to the *pericardium*, and to join with the branches of the intercostal that are distributed to the heart; but their size and situation are uncertain.

After these branches are sent off, the *par vagum* on each side descends behind the great branch of the *trachea*, and gives numerous filaments to the lungs, and some to the heart, in going to the *æsofphagus*. The one of the left side running on the fore-part of the *æsofphagus*, communicates by several branches with the right one in its descent to be distributed to the stomach: The right one gets behind the *æsofphagus*, where it splits and re-joins several times before it arrives at the stomach, to which it sends nerves; and then being joined by one or more branches from the left trunk, they run towards the *cæliac* artery, there to join into the great *semilunar ganglion* formed by the two intercostals.

From the distribution of this *par vagum*, we may learn how tickling the *fauces* with a feather or any such substance, excites a *nausea* and inclination to vomit;—why coughing occasions vomiting, or vomiting raises a cough.—Hence we see how the nervous *asthma*, and the *tussis convulsiva*, chincough, are attended with a straitening of the *glottis*;—why food difficult to digest occasions the *asthma* to weakly people, and why *emetics* have frequently cured the *asthma* very speedily;—why an attempt to vomit is sometimes in danger of suffocating *asthmatic* people;—why the superior orifice of the stomach is so sensible, as to be looked on as the seat of the soul by some;—why people subject to distensions of the stomach, have so often the

sensation of balls in their breasts and throats;—why the *globus hystericus* is so often attended with a violent strangulation at the *glottis*.

The NINTH PAIR of nerves comes from the inferior part of the *corpora pyramidalia*, to go out of the skull at their proper holes of the occipital bone. After their egress they adhere for some way firmly to the eighth and intercostal; and then sending a branch, that in many subjects is joined with branches of the first and second cervical nerves, to be distributed to the thyroid gland and muscles on the fore-part of the *trachea arteria*, the ninth is lost in the muscles and substance of the tongue. Some have thought this nerve, and others have esteemed the third branch of the fifth pair of nerves, to be the proper gustatory nerve. I know no observation or experiments to prove either opinion, or to assure us that both nerves do not serve for tasting and for the motion of the tongue.—May not the distribution of this nerve to the muscles below as well as above the *os hyoides*, contribute to their acting more uniformly in depressing the lower jaw or head?

The TENTH PAIR rises in separate threads from the sides of the *spinal marrow*, to go out between the *os occipitis* and *first vertebra* of the neck. After each of them has given branches to the great ganglion of the intercostal, 8th, 9th, and 1st cervical nerves, it is distributed to the straight, oblique, and some of the extensor muscles of the head. Whether the name of *tenth of the head*, or of *the first vertebral*, ought to be given to this pair of nerves, is of no such consequence as to deserve a debate; tho' it has some of the marks of the spinal nerves, to wit, its being formed of filaments proceeding from both the fore and back part of the *medulla*, and a little *ganglion* being formed where these filaments meet.

In the description of the sixth pair, I followed the usual way of speaking among anatomists, and called *that* the beginning of the intercostal nerve which comes out of the skull; and therefore shall here subjoin a cursory description of this nerve, notwithstanding its much larger part is composed of nerves coming out from the *spinal marrow*. There is no greater incongruity in point of method to say, that the nerve we are describing receives additions from others that have not been described, than it is to repeat, in the description of a great many nerves, that each of them gives branches to form a nerve which we are ignorant of; which is

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all the difference between describing the intercostal before or after the spinal nerves.

The branch reflected from the sixth pair, joined possibly by some filaments of the *ophthalmic* branch of the fifth, runs along with the internal carotid artery, through the crooked canal formed for it in the *temporal bone*, where the little nerve is very soft and pappy, and in several subjects divides and unites again, and is joined by one or more branches from the fifth, particularly of its superior maxillary branch, before it comes out of the skull. May not the compression of this nerve by the carotid artery, when stretched during the *systole*, contribute to the *diastole* of the heart? As soon as the nerve escapes out of this bony canal, it is connected a little way with the eighth and ninth; then separating from these, after seeming to receive additional nerves from them, it forms a large *ganglion*, into which branches from the tenth of the head, and from the first and second cervical, enter. From this ganglion the nerves come out again small to run down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the muscles that bend the head and neck. As the *intercostal* is about to enter the *thorax*, it forms another ganglion, from which nerves are sent to the *trachea* and to the heart; those designed for the heart joining with the branches of the eighth, and most of them passing between the two great arteries and the auricles to the substance of that muscle. The intercostal after this, consisting of two branches, one going behind, and the other running over the fore-part of the subclavian artery, forms a new ganglion where the two branches unite below that artery; and then, descending along the sides of the *vertebræ* of the *thorax*, receives branches from each of the dorsal nerves; which branches appearing to come out between the ribs, have given the name of *intercostal* to the whole nerve. Where the addition is made to it from the fifth dorsal nerve, a branch goes off obliquely forwards; which being joined by such branches from the sixth, seventh, eighth, and ninth dorsal, an anterior trunk is formed, and passes between the *appendix musciosa* of the diaphragm, to form, along with the other intercostal and the branches of the eighth pair, a large semilunar ganglion, situated between the cæliac and superior mesenteric arteries; the roots of which are as it were involved in a sort of nervous net-work of this ganglion, from which

a great number of very small nervous threads run out to be extended on the surface of all the branches of those two arteries, so as to be easily seen when any of the arteries are stretched, but not to be raised from them by dissection; and thus the *liver*, *gall-bladder*, *duodenum*, *pancreas*, *spleen*, *jejunum*, *ilium*, and a large share of the *colon*, have their nerves sent from this great *solar ganglion* or *plexus*—May not the peristaltic motion of the intestines depend in some measure on the passage of the intercostal nerves through the diaphragm?

Several fibres of this ganglion, running down upon the *aorta*, and meeting with other nerves sent from the posterior trunk of the intercostal, which continues its course along the sides of the *vertebræ*, supply the *glandulæ renales*, kidneys, and *testes* in men, or *ovaria* in women; and then they form a net-work upon the inferior mesenteric artery where the nerves of the two sides meet, and accompany the branches of this artery to the part of the *colon* that lies in the left side of the belly, and to the *rectum*, as far down as to the lower part of the *pelvis*.

The intercostal continuing down by the side of the *vertebræ* of the loins, is joined by nerves coming from between these *vertebræ*, and sends nerves to the organs of generation, and others in the *pelvis*, being even joined with those that are sent to the inferior extremities.

The almost universal connection and communication which this nerve has with the other nerves of the body, may lead us to understand the following and a great many more *phænomena*:—Why tickling the nose causes sneezing;—why the too great quantity of bile in the *cholera* occasions vomiting as well as purging;—why people vomit in cholics, in inflammations, or other irritations of the liver, or of the ducts going from it, and the gall-bladder;—why a stone in the kidneys, or ureters, or any other cause irritating those organs, should so much more frequently bring on vomiting and other disorders of the stomach, than the stone or any other stimulating cause in the bladder does;—why vomiting is a symptom of danger after child-birth, lithotomy, and other operations on the parts in the *pelvis*;—why the obstructions of the *menfes* are capable of occasioning strangulations, belching, cholics, stomach-achs, and even convulsions in the extremities;—why vesicatories, applied from the ears to the clavicles of children labouring under the *tussis convulsiva*, are frequently of great service;

service;—why worms in the stomach or guts excite an itching in the nose, or grinding of the teeth;—why irritations in the bowels or the belly occasion sometimes universal convulsions of the body.

The *spinal* nerves rise generally by a number of disgregated fibres from both the fore and back part of the *medulla spinalis*, and soon after form a little knot or ganglion, where they acquire strong coats, and are extended into firm cords. They are distinguished by numbers, according to the *vertebræ* from between which they come out; the superior of the two bones forming the hole through which they pass, being the one from which the number is applied to each nerve. There are generally said to be *thirty pair* of them; seven of which come out between the *vertebræ* of the *neck*, twelve between those of the *back*, five between those of the *loins*, and six from the *false vertebræ*.

The **FIRST CERVICAL** pair of nerves comes out between the first and second *vertebræ* of the neck; and having given branches to join with the tenth pair of the head, the second cervical and intercostal, and to serve the muscles that bend the neck, it sends its largest branches backwards to the extensor muscles of the head and neck; some of which piercing through these muscles, run up on the *occiput* to be lost in the teguments here; and many fibres of it advance so far forward, as to be connected with the *fibrils* of the first branch of the fifth pair of the head, and of the *portio dura* of the *auditory nerve*.—Hence possibly it is that a *clavus hyssericus* changes suddenly sometimes from the forehead to a violent pain and spasm in the back-part of the head and neck.

The **SECOND CERVICAL** is soon joined by some branches to the ninth of the head and intercostal, and to the first and third of the neck; then has a large branch that comes out at the exterior edge of the *sterno-mastoideus* muscle, where it joins with the *accessorius* of the eighth pair; and is afterwards distributed to the *platysma myoides*, teguments of the side of the neck and head, parotid gland, and external ear, being connected to the *portia dura* of the auditory nerve, and to the first cervical. The remainder of this second cervical is spent on the *levator scapulæ* and the extensors of the neck and head. Generally a large branch is here sent off to join the *accessorius* of the eighth pair, near the superior angle of the *scapula*.

To the irritation of the branches of this nerve it probably is, that, in

an inflammation of the parotid gland, the neck is pained so far down as the clavicle, the head is drawn towards the shoulder of the affected side, and the chin is turned to the other side.—In opening the external jugular vein, no operator can promise not to touch some of the cutaneous branches of this nerve with the lancet; which occasions a sharp pricking pain in the mean time, and a numbness of the skin near the orifice for some time after.

The THIRD PAIR of the neck passes out between the third and fourth cervical *vertebræ*, having immediately a communication with the second, and sending down a branch, which, being joined by a branch from the fourth cervical, forms the PHRENIC nerve. This, descending, enters the *thorax* between the subclavian vein and artery; and then being received into a groove formed for it in the *pericardium*, it has its course along this *capsula* of the heart, till it is lost in the middle part of the diaphragm. The right phrenic has a straight course; but the left one is obliged to make a considerable turn outwards to go over the prominent part of the *pericardium* where the point of the heart is lodged. Hence, in violent palpitations of the heart, a pungent acute pain is felt near the left orifice of the stomach.—The middle of the diaphragm scarce could have been supplied by any other nerve which could have had such a straight course as the *phrenic* has. If the subclavian artery and vein have any effect upon this nerve, I do not know it.

The other branches of the third cervical nerve are distributed to the muscles and teguments at the lower part of the neck and top of the shoulder. No wonder then that an inflammation of the liver or spleen, an abscess in the lungs adhering to the diaphragm, or any other cause capable of irritating the diaphragm, should be attended with a sharp pain on the top of the shoulder, as well as wounds, ulcers, &c. of this muscle itself.—If the irritation of this muscle is very violent, it may occasion that convulsive contraction of the diaphragm which is called an *hiccough*; and therefore an hiccough in an inflammation of the liver, has been justly declared to be an ill symptom.

An irritation of the thoracic nerves which produces sneezing, may sometimes free the phrenic nerves from any spasm they occasion; so that sneezing sometimes takes away the hiccough; and a derivation of the fluid

fluid of the nerves any other way may do the same thing: Or the hic-cough may also be sometimes cured, by drawing up into the nose the smoke of burning paper or other acrid fumes, swallowing pungent or aromatic medicines, and by a surprise, or any other strong application of the mind in thinking, or in distinguishing objects: Or when all these have failed, it has been put away by the brisk *stimulus* of a blistering plaster applied to the back.

The FOURTH CERVICAL nerve, after sending off that branch which joins with the third to form the phrenic, and bestowing twigs on the muscles and glands of the neck, runs to the arm-pit, where it meets with the FIFTH, SIXTH, and SEVENTH cervicals, and FIRST DORSAL, that escape in the interstices of the *musculi scaleni*, to come at the arm-pit, where they join, separate, and rejoin, in a way scarce to be rightly expressed in words; and after giving several considerable nerves to the muscles and teguments which cover the *thorax*, they divide into several branches, to be distributed to all the parts of the superior extremity. Seven of these branches I shall describe under particular names.

1. SCAPULARIS runs straight to the *cavitas semilunata* of the upper *costa* of the *scapula*, which is a hole in the recent subject, by a ligament being extended from one angle of the bone to the other, giving nerves in its way to the muscles of the *scapula*. When it has passed this hole, it supplies the *supra spinatus* muscle; and then descending at the anterior root of the *spine* of the *scapula*, it is lost in the other muscles that lie on the *dorsum* of that bone.

2. ARTICULARIS sinks downwards at the *axilla*, to get below the neck of the head of the *os humeri*, and to mount again at the back-part of it; so that it almost surrounds the articulation, and is distributed to the muscles that draw the arm back, and to those that raise it up.

3. CUTANEUS runs down the fore-part of the arm near the skin, to which it gives off branches; and then divides on the inside of the forearm into several nerves, which supply the teguments there, and on the palm of the hand.—In opening the basilic vein of the arm, at the ordinary place, the same symptoms are sometimes produced as in opening the external jugular vein, and from a like cause, to wit, from hurting a branch of this cutaneous nerve with the lancet.

4. MUSCULO-CUTANEUS, or *perforans Casseri*, passes through the *coracobrachialis* muscle; and after supplying the *biceps flexor cubiti* and *brachialis internus*, passes behind the tendon of the *biceps*, and over the cephalic vein, to be bestowed on the teguments on the outside of the fore-arm and back of the hand.—This nerve is sometimes hurt in opening the cephalic vein, and causes pain and numbness for a short time.

5. MUSCULARIS has a spiral course from the *axilla*, under the *os humeri*, and backward to the external part of that bone; supplying by the way the extensor muscles of the fore-arm, to which it runs between the two *brachiae* muscles, and within the *supinator radii longus*.—At the upper part of the fore-arm, it sends off a branch, which accompanies the *supinator longus* till it comes near the wrist, where it passes obliquely over the *radius*, to be lost in the back of the hand and fingers.—The principal part of this nerve pierces through the *supinator radii brevis*, to serve the muscles that extend the hand and fingers, whose actions are not injured when the *supinator* acts.

6. ULNARIS is extended along the inside of the arm, to give nerves to the muscles that extend the fore-arm and to the teguments of the elbow: towards the lower part of the arm, it slants a little backward to come at the groove behind the internal condyle of the *os humeri*, through which it runs to the *ulna*. In its course along this bone, it serves the neighbouring muscles and teguments; and as it comes near the wrist, it detaches a branch obliquely over the *ulna* to the back of the hand, to be lost in the convex part of several fingers. The larger part of the nerve goes straight forward to the internal side of the *os pisiforme* of the wrist; where it sends off a branch which sinks under the large tendons in the palm, to go cross to the other side of the wrist, serving the *musculi lumbricales* and *interossei*, and at last terminating in the short muscles of the thumb and fore-finger. What remains of the ulnar nerve, after supplying the short muscles of the little-finger, divides into three branches; whereof two are extended along the sides of the sheath of the tendons of the flexors of the little-finger, to furnish the concave side of that finger; and the third branch is disposed in the same way upon the side of the ring-finger next to the little-finger.

When we lean or press on the internal condyle of the *os humeri*, the numbness

numbness and prickling we frequently feel, point out the course of this nerve. I have seen a weakness and atrophy in the parts which I mentioned this nerve to be sent to, after a wound in the internal lower part of the arm.

7. *RADIALIS* accompanies the humeral artery to the bending of the elbow, serving the flexors of the cubit in its way; then passing through the *pronator radii teres* muscle, it gives nerves to the muscles on the fore-part of the fore-arm, and continues its course near to the *radius*, bestowing branches on the circumjacent muscles. Near the wrist, it sometimes gives off a nerve which is distributed to the back of the hand, and the convex part of the thumb and several of the fingers, instead of the branch of the muscular. The larger part of this nerve, passing behind the annular ligament of the wrist, gives nerves to the short muscles of the thumb; and afterwards sends a branch along each side of the sheath of the tendons of the flexors of the thumb, fore-finger, mid-finger, and one branch to the side of the ring-finger, next to the middle one, to be lost on the concave side of those fingers.

Though the *radial* nerve passes through the *pronator* muscle, and the *muscular* nerve seems to be still more unfavourably placed within the *supinator brevis*, yet the action of these muscles does not seem to have any effect in hindering the influence of these nerves; for the fingers or hand can be bended while pronation is performing vigorously, and they can be extended while supination is exercised.

The manner of the going off of these nerves of the fingers, both from the *ulnar* and *radial*, is, that a single branch is sent from the trunk to the side of the thumb and little-finger farthest from the other fingers; and all the rest are supplied by a trunk of a nerve, which splits into two, some way before it comes as far as the end of the *metacarpus*, to run along the sides of different fingers that are nearest to each other.

It might have been observed, that, in describing the posterior branches of the *ulnar* and *muscular* nerve, I did not mention the particular fingers, to the convex part of which they are distributed. My reason for this omission is the uncertainty of their distribution: for though sometimes these posterior branches go to the same fingers, to the concave part of

which the anterior branches of the *ulnar* and *radial* are sent, yet frequently they are distributed otherwise.

The situation of these brachial nerves in the *axilla* may let us see how a weakness and atrophy may be brought on the arms by long-continued pressure of crutches, or such other hard substances, on this part; and the course of them from the neck to the arm may teach us, how much better effects vesicatories, or stimulating nervous medicines, would have, when applied to the skin, covering the transverse processes of the *vertebræ* of the neck, or at the *axilla*, than when they are put between the shoulders, or upon the spinal processes, in convulsions or palsies of the superior extremities, where a *stimulus* is required.

The TWELVE DORSAL nerves of each side, as soon as they escape from between the *vertebræ*, send a branch forward to join the intercostal, by which a communication is made among them all; and they soon likewise give branches backwards to the muscles that raise the trunk of the body, their principal trunk being extended outwards to come at the furrow in the lower edge of each rib, in which they run toward the anterior part of the *thorax*, between the internal and external intercostal muscles, giving off branches in their course to the muscles and teguments of the *thorax*.

The FIRST dorsal, as was already observed, is particular in this, that it contributes to form the brachial nerves; and that the two branches of the intercostal, which come down to the *thorax*, form a considerable ganglion with it.

The SIX lower dorsal nerves give branches to the diaphragm and abdominal muscles.

The TWELFTH joins with the first lumbar, and bestows nerves on the *musculus quadratus lumborum* and *iliacus internus*.

May not the communications of all these nerves be one reason, why the parts they serve act so uniformly and conjunctly in respiration, and conspire together in the convulsive motions of coughing, sneezing, &c. — The twitching spasms that happen sometimes in different parts of the muscles of the *abdomen*, by an irritation on the branches of the lower dorsal nerves, are in danger of occasioning a mistake in practice, by their resemblance to the colic, *nephritis*, &c. — The communications of these
lower

lower ones with the intercostals, may serve to explain the violent effort of the abdominal muscles in a *teneismus*, and in child-bearing.

As the intercostal is larger in the *thorax* than any where else, and seems to diminish gradually as it ascends and descends, there is cause to suspect that this is the trunk from which the superior and inferior pairs are sent as branches.

The FIVE LUMBAR nerves on each side communicate with the intercostal and with each other, and give branches backwards to the loins.

The FIRST communicates with the last dorsal, sends branches to the abdominal muscles, to the *psoas* and *iliacus*, and to the teguments and muscles on the fore-part of the thigh; while its principal branch joins with the other nerves to form the crural nerve.

The SECOND LUMBAR nerve passes through the *psoas muscle*, and is distributed nearly in the same way as the former: as is also the THIRD.

Branches of the *second*, *third*, and *fourth*, make up one trunk, which runs along the fore-part of the *pelvis*; and, passing in the notch at the fore-part of the great hole common to the *os pubis* and *ischium*, is spent on the *adductor* muscles, and on the teguments on the inside of the thigh. This nerve is called the OBTURATOR, or POSTERIOR CRURAL NERVE.

By united branches from the *first*, *second*, *third*, and *fourth* lumbar nerves, a nerve is formed that runs along the *psoas* muscle, to escape with the external iliac vessels out of the *abdomen*, below the tendinous arcade of the external oblique muscle. This nerve, which is named the ANTERIOR CRURAL, is distributed principally to the muscles and teguments on the fore-part of the thigh. A branch, however, of this nerve, runs down the inside of the leg to the upper part of the foot, keeping near to the *vena saphæna*; in opening of which with a lancet at the ankle, the nerve is sometimes hurt, and occasions sharp pain at the time of the operation, and numbness afterwards.

The remainder of the fourth lumbar and the fifth join in composing the largest nerve of the body; which is soon to be described.

Whoever attends to the course of these lumbar nerves, and of the spermatic vessels and nerves upon the *psoas* muscle, with the oblique passage of the *ureter* over that muscle, will not be surprised, that, when a stone is passing in this canal, or even when it is inflamed, the trunk of the body cannot

cannot be raised erect without great pain; or that the skin of the thigh becomes less sensible, and the thigh is drawn forward; and that the testicle often swells, and is drawn convulsively towards the ring of the abdominal muscles.

The SIXTH PAIR of the false VERTEBRÆ consist each of small posterior branches sent to the hips, and of large anterior branches.

The *first*, *second*, and *third*, after coming through the three upper holes in the fore-part of the *os sacrum*, join together with the fourth and fifth of the loins, to form the largest nerve of the body, which is well known by the name of SCIATIC or ISCHIATIC nerve: This, after sending large nerves to the different parts of the *pelvis*, and to the external parts of generation and the *podex*, as also to the muscles of the hips, passes behind the great *tuber* of the *os ischium*, and then over the *quadrigemini* muscles to run down near to the bone of the thigh at its back-part, giving off nerves to the neighbouring muscles and teguments. Some way above the ham, where it has the name of the *popliteus* nerve, it sends off a large branch that passes over the *fibula*, and, sinking in among the muscles on the anterior external part of the leg, runs down to the foot, to be lost in the upper part of the larger toes, supplying the neighbouring muscles and teguments every where in its passage. The larger branch of the *sciatic*, after giving branches to the muscles and teguments about the ham and knee, and sending a large cutaneous nerve down the calf of the leg, to be lost at last on the outside of the foot and upper part of the lesser toes, sinks below the *gemellus* muscle, and distributes nerves to the muscles on the back of the leg; among which it continues its course, till, passing behind the internal *malleolus*, and in the internal hollow of the *os calcis*, it divides into the two plantar nerves: The internal of which is distributed to the toes in the same manner that the *radial* nerve of the hand serves the concave side of the thumb and fingers; and the external *plantar* is divided and distributed to the sole of the foot and toes, nearly as the *ulnar* nerve is in the palm of the hand, and in the concave part of the fingers.

Several branches of these nerves, that serve the *inferior extremities*, pierce through muscles.

By applying what was said of the nerves in general to the particular distribution

distribution of the nerves of the *inferior extremities*, we may see, How people with fractured legs, especially where there are splinters, should be subject to convulsive startings of the fractured member:—Why, upon tying the blood-vessels in an amputation of the leg, the patients should sometimes complain of violent pain in their toes;—why such patients should also be troubled with startings;—why, for a considerable time after the amputation of the diseased limb, when the suppuration is well advanced, they should complain of pain in the fore which occasioned the amputation.

The FOURTH, which, with the two following, is much smaller than the three superior, soon is lost in the *vesica urinaria* and *intestinum rectum*.

The FIFTH comes forward between the extremity of the *os sacrum* and *coccygis*, to be distributed principally to the *levatoris ani*.

The SIXTH, which some think to be only a production of the *dura mater*, advances forward below the broad shoulders of the first bone of the *os coccygis*, and is lost in the *sphincter ani* and teguments covering it.

The branches of the four last cervical nerves, and of the first dorsal, which are bestowed on the *superior extremities*, and the two crurals, with the sciatic, which are distributed to the *inferior extremities*, are much larger proportionally to the parts they serve, than the nerves of the trunk of the body, and especially of the *viscera*, are; and for a very good reason, that, in the most common necessary actions of life, a sufficient quantity of fluid, on which the influence of nerves seems to depend, may be supplied to the muscles there, which are obliged to perform more frequent and violent contractions than any other parts do.—The size of the nerves of the *inferior extremities* seems larger proportionally than in the *superior extremities*; the *inferior extremities* having the weight of the whole body to sustain, and that frequently at a great disadvantage.—What the effect is of the nerves here being injured, we see daily, when people happen, by sitting wrong, to compress the sciatic nerve; they are incapable for some time after to support themselves on the affected *extremity*: And this is still more remarkable in the *sciatic* or *hip-gout*, in which the member is not only weakened, but gradually shrivels and wastes.

N^o II.

A N

E S S A Y

ON THE

NUTRITION OF FOETUSES.

A N
E S S A Y
O F T H E
N U T R I T I O N O F F O E T U S E S.

WHILE our senses and judgment are in the present imperfect state, it is no wonder that men should differ widely in their opinions of things, and so in the consequences they draw from the appearances in nature. Such is the case at present between my ingenious valuable friend Mr Gibson and me. He has given a learned critical account of the different opinions concerning the “nourishment of foetuses” in the *Edin. Med. Essays*, Vol. I. art. xiii. where, after examining the arguments made use of for proving their nourishment to be conveyed by the navel only, he concludes them to be insufficient, and supports the doctrine of the aliment being received by both the mouth and navel. I formerly wrote Mr Cheselden, and he published some facts serving principally for proving the negative of a foetus taking its food at the mouth: so that Mr Gibson very justly names me as one of those who differ in opinion from him, which I cannot help doing still; and therefore believe myself engaged to give my reasons of dissent; since there is no certainty that Dr Bellenger, whom he more directly attacks, either has seen, or will answer, my friend’s essay.

Mr Gibson having already mentioned the most material arguments made use of to support the doctrine he favours, I shall faithfully represent any other reasons furnished by books, or my own reflections, which favour his side of the question; and therefore replies will be at least shorter, if not unnecessary.

I shall pass without any examination Alcmeon's opinion of the foetus receiving its nourishment by the pores or vessels on the surface of its body while it is a-forming; both because there are no experiments for proving whether the veins there take in more at this time than the arteries throw out; and that it is not the subject of the present question, which only concerns the foetus after it is formed; whose nourishment is now allowed by all, either to pass from the amnios by the mouth into its chylopoietic organs, or to be conveyed into its blood-vessels by means of the umbilical vessels, or to be furnished by both. I maintain the second of these opinions, and therefore endeavour to render the other two improbable; though thereby I am under the disadvantage of supporting a negative proof.

The determination of the question, as now stated, may be reduced to the solution of the few following problems.

I. How far the mouth or umbilical vessels are necessary to the nourishment of foetuses.

II. Whether the liquor of the amnios is proper food for a foetus.

III. Whether this liquor passes into the stomach of a foetus.

I shall first consider these problems, so far as they relate to viviparous animals; and shall, in another section, examine, 'How far the analogy of oviparous animals, and of plants, serves to explain or confirm the solutions which I give to the foregoing problems.'

S E C T I O N I.

IN treating this subject, I must beg leave to throw away that humble regard to authority, which bore sovereign sway in the schools of physic so long, and to pass all the hypothetical reasonings to be met with in books,

books, unmentioned. It is only well-vouched facts, and reasonable consequences from them, that I will take any notice of; for on these, and on these only, it is, that a rational foundation of any part of medicine can be laid. The first thing therefore which I shall do, is to set down such facts as I may have occasion to assume in my subsequent reasoning, together with some others, serving either to confirm and establish those, or to render them more clear and intelligible; though few of them are new, yet most of them are neglected in the common books of anatomy, and no author of my acquaintance has collected them.

That the truth of these facts may be more unquestionable, I shall either point out the manner in which others may observe them; or where I had not the opportunity of an exact enough examination myself, I shall quote my vouchers, who are authors of the best characters for knowledge and candour: And if I affirm at any time the being or structure of things that are not demonstrable to the sight, I shall set down other facts from which they seem to be plainly and necessarily concluded to be true. But, because my design confines me from entering into very particular minute descriptions, I generally refer to books where such descriptions are to be had, so that those who desire to be more fully instructed may know where to be informed; and others who do not incline to give themselves any further trouble, may believe as well as they please of my honesty, and will meet with no great interruption in reading by the small mark of reference to the quotations.

THE PRELIMINARY FACTS.

1. The human uterus has numerous orifices of vessels opening into its cavities to pour out liquors there (*a*).

These liquors may at any time be seen oozing out, by gently pressing the substance of an opened uterus.

2. Towards the fundus of the womb especially, these orifices are found to be the extremities of canals that come out from larger cavities lodged within the substance of the womb; these cavities are commonly called *sinuses* (*b*).

3. The

(*a*) Tho. Bartholin. Anat. Reform. lib. i. cap. 28. Santorin. Observ. Anat. cap. xi. § 11.

(*b*) Bartholin. Anat. Reform. lib. i. cap. 28. Morgagn. Advers. Anat. iv. animad. 26, 27.

3. The sinuses are much of the same texture with the cells of the spleen, or rather of the *corpora cavernosa penis*, being membranous cavities communicating with each other, and having numerous arteries spread on them, whose lateral branches open into the cells, from which veins go out to be joined to other veins that return the blood from the other parts of the womb (*a*).

4. These sinuses are distended with blood in the time of the menses, when their orifices also are enlarged (*b*).

I have seen this in several women I dissected.

5. During the time of pregnancy, the sinuses and their canals that open into the womb are gradually distended and enlarged.

In a woman who died three or four months gone with child, I saw the orifices of these canals large enough to receive a goose-quill, the sinuses being considerably larger. At the end of nine months the sinuses can contain the point of the largest finger (*c*), and the canals from them can receive the little finger (*d*). This I saw in two wombs.

6. Besides the reticular bundles of muscular fibres, which enter into the structure of the womb (*e*), I have twice seen, where the placenta adhered, what agreed exactly with Ruyfch's description and picture of what he calls the orbicular muscle (*f*): but, having missed it in four other fit subjects, and considering the thickness, softness, and succulency of the villous and internal cellular coats covering the inner side of the muscular fibres of the womb, I suspected that I had too much faith in Ruyfch, and therefore too hastily, without sufficient examination, concluded what had an orbicular appearance on the internal surface of the womb of the first two subjects to be muscular; I now rather believe it to be only a print made by the placenta upon the soft surface of the womb.

7. The placenta generally adheres to, or near to, the fundus of the womb.

All agree in this. In five women with child, whom I had occasion to open, the placenta adhered to the interior part of the fundus.

8. The

(*a*) Malpigh. in epist. ad Spon.—Littre, in Memoires de l'Acad. des Sciences, 1701.

(*b*) Bartholin. Anat. Ref. lib i. cap. 28. Morgagn. Advers. Anat. i. § 33. Adv. iv. § 27.

(*c*) Santorin. Obser. Anat. cap. 11. § 9. Morgagn. Adv. Anat. iv. § 29.

(*d*) Morgagn. ibid.

(*e*) Malpigh. in epist. ad Spon.

(*f*) Ruyfch, Epist. de musc. in fundo uteri.

8. The placenta is covered, on the side next to the womb, with a fine membranous continuation of the chorion (*a*).

I saw this distinctly in the five subjects I dissected.

9. The extremities of the umbilical vessels pierce this membrane, and shew their very small orifices on its side next to the uterus; and therefore it is compared to the villous coat of the intestines (*b*).

The orifices of these vessels of the villous surface of the placenta are so small, that even lukewarm water, injected by the umbilical arteries, or by the vein of a placenta which had this membrane entire, when pushed with all the force that I could apply to the syringe, only oozed out at a number of such small orifices as I could not perceive, and it came out so slowly that I was unable to continue pushing the syringe till I could make eight ounces of the water pass through them. When oil of turpentine with the finest powder of vermilion was injected, the oil oozed out, but brought none of the powder with it, though the oil which returned into the umbilical vein, when the injection was thrown in by the arteries, was coloured with the vermilion.

10. The allantois was carefully sought for in all the five subjects I opened; but we could see no such cavity, or liquor in it. The membranes had a loose connection, by a cellular substance, and a fine transparent membrane was observed between the chorion and amnios.

11. The uteri of other animals have vessels opening into their cavities, as well as the human womb, and the same trial discovers them; and, during gravitation, the internal membrane becomes villous, and has a thick succulent cellular substance interposed between it and the muscular coat.

12. The membranous continuation of the chorion is not so evident on the exterior surface of the placenta of brutes, as in the human subject; but their secundines have numerous orifices of the umbilical vessels opening on their surface next to the uterus, as is evidently demonstrated by injecting a thin liquor into the umbilical vein or arteries; for it soon comes running out every where from the exterior surface of the placenta and chorion,

(*a*) Ruyfch. Thef. Anat. xi. Affr. iv. n. 18. not. 1. & Thef. v. n. 41.—Santorin. Observ. Anat. cap. 11. § 11.

(*b*) Ruyfch. Thef. v. n. 41. Rouhault—Memoires de l'Acad. des Sciences, 1714, & 1717.

tion, carrying the powder of vermilion or verdigrease along with it; which shews the extremities of the vessels to be larger here than the villous membrane of the human placenta, § 9.

13. The mother supplies liquors to the foetus, which returns others to the mother by means of the uterine and umbilical vessels.

This seems to be plainly proved by observations. Foetuses, whose placenta were not in the least separated from the uterus, have been quite exhausted of blood by the mother's dying of an hæmorrhage (*a*); and I have seen children pale and weak, by violent flooding in the time of labour.

14. When a foetus dies, or is separated from its secundines by cutting the umbilical rope, the circulation of liquors is wholly stopped in the vessels of the secundines, and these become a lifeless mass.

The experience of our greatest practisers in midwifery sufficiently proves this. They tell us, that no hæmorrhage or discharge of any other liquor happens at the umbilical vessels, upon the navel-string's being cut or broke, after the vessels are secured on the side of the child, as I have also seen frequently: and another proof is the placenta commonly separating in a shrivelled or suppurated state, soon after the communication with the child is destroyed (*b*).

When one is to observe whether the umbilical vessels have a circulation of blood kept up in them, after their communication with the child is stopped or destroyed, he needs scarce be desired not to mistake a few drops of blood, such as would come from an amputated limb of a dead person, for an hæmorrhage; but he ought to observe one caution, which is, to make sure, before the trial, that there is no foetus left with its navel-string untied or uncut: for in the case of twins, when often the placenta are blended, and sometimes one navel-string serves both (*c*), tho' one child is taken away, the other may fill the vessels of the placenta, and continue their functions; so that an hæmorrhage would happen at the cut, but untied, navel-string of the first child. We have an instance of

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(*a*) Mery, dans l'Hist. de l'Acad. des Sciences, 1708. Heister, *Compend Anat.* not. 36.

(*b*) Mauriceau, *Maladies des Femmes grosses*, liv. 2. chap. 7. Ruysch, in *Thef. observ.* et *adverf.*

(*c*) *Mem. de l'Acad. des Sciences*, 1720. *Act. Medic. Berol.* dec. 6. vol. iv. § 4.

a mother and child being almost wholly drained of their blood, by the midwife's neglecting to tie the navel-string of the first of the twins, which was brought forth without perceiving that the other still remained in the womb (*a*). This case ought to be added to the histories brought in proof of § 13.

15. That power which physicians generally now a-days call absorption, whereby the small open orifices of vessels imbibe liquors lodged in the cavities of the body, is observed to increase or diminish proportionally to the strength or weakness of the creature.

In diseases where the contraction of the vessels is too great, as in most of those that are called acute, there is scarce as much moisture in the cavities or interstices of the parts, as allows them to slide easily one upon another. In health, the quantity of such liquors is moderate, and a pretty constant equality is kept between the action of the exhalants and of the absorbents: but when the body turns weak, the exhalants pour out so much more than the absorbents can take in, that all the cavities are found to contain considerable quantities of liquors. After death, the action of the absorbents seldom or never can be supplied by any mechanical pressure. For examples of what has been said concerning absorption, consider the common phenomena which are to be observed in the long alimentary tube, in the large cavities of the abdomen, thorax, pericardium, &c. and in the smaller cavities of the tunica cellularis every where, of the cornea, &c. both in a sound and morbid state.

Hence we may understand how purgatives or diuretics may serve to drain off extravasated hydropic waters, by stimulating the vessels to a stronger absorption; and how corroborants may produce the like effect, though more slowly.

16. The liquors (§ 13.) are not carried from the mother to the foetus, or from the foetus to the mother, by continued canals; that is, the uterine arteries and veins do not anastomose with the veins and arteries of the secundines (*b*): but the extremities of the umbilical vein take up the liquors by absorption, in the same way as the lacteal vessels do in the guts;

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and

(*a*) Histoire de l'Acad. des Sciences, 1727.

(*b*) Harvey de Generat. Animal. exercit. 70. Ruyfch, Thes. v. n. 41.

and the umbilical arteries pour their liquors into the large cavities of the sinuses, or other cavities analogous to them.

Were I allowed to illustrate the communication between a mother and her child in the womb, by a gross comparison, I would say that the uterine sinuses are to a foetus what the intestines are to an adult: The uterine blood poured into the sinuses being analogous to the recent ingesta of food and drink: The liquors sent from the umbilical arteries to be mixed with the uterine blood, resemble the bile, pancreatic juice, and the other liquors separated from the mass of blood: The umbilical veins, and those on the surface of the chorion, take up the finer part of this compound mass, as the lacteal and meseraic veins do from the contents of the guts: And the grosser parts of the blood in the sinuses are carried back by the veins of the womb, as the excrements of the guts are discharged at the anus.

It is plain, from the disproportionate size of the human sinuses, and of their excretory canals, to the very small extreme umbilical vessels, (compare § 5. and 9.), that there can be no anastomosis by continued canals supposed here; which also seems to be proved next to a demonstration by § 14. For if the vessels of the secundines anastomosed, an hæmorrhage or flux of some liquors would happen at the umbilical vein whenever the navel-string was broke or cut, and would continue as long as the after-burden adhered to the uterus; and if the umbilical vessels were tied, the circulation would still continue in the placenta, and it would not become a lifeless mass: But the reverse of all these are observed; which makes a most sure proof of the communication of the placenta with the uterus being destroyed as soon as the navel-string is divided; and as § 14. shews the secundines to owe their life and action to the foetus, so the reason of their taking in no fluids, after it is separated, is evident from § 15.

In brutes, we can observe no tearing or breaking of vessels when we separate the placenta from their uteri; and when any liquor is injected into their uterine arteries, none of it does pass into the umbilical vessels, as I have many times fully tried in the glanduliferous animals, cows, sheep, &c. and in some others. In many animals, the secundines and

uterus

uterus do not adhere for a considerable time (*a*): and in some of these, mares for instance, in whose secundines the allantois is every where interposed between the chorion and amnios (*b*), there is no way for any nourishment to be conveyed to the foetus, except by the vessels of the secundines; which therefore can only take up their liquors by absorption: and why may not the same obtain in other animals?

It is worth while to remark, by the way, the inconveniencies that are shunned by the want of an anastomosis between the vessels of the womb and secundines. The violence of the mother's circulating fluids is not in hazard of destroying the embryo while tender: and there are no vessels to be broken or torn at birth, which would have required too much force in bringing away the placenta, and would have brought on inflammation, suppuration, and other bad symptoms.

Some gentlemen who contend for an anastomosis, are so sensible of these inconveniencies, that, to shun having them objected to them, they will not allow the anastomosing canals to be of one continued substance, but suppose the vessels of the uterus and secundines to be joined only *per appositionem*; which they explain to be, by the one sort receiving the other some way within them, in the same manner as the second sort of pipes receive the first in the injecting instruments (*a*): so that the coats of the vessels being thus contiguous, they may serve for the transmission of liquors, as well as if they were of the same continued substance, and may be separated with a small force, and without any laceration.

This supposition takes off indeed the objection of such inconveniencies, but is itself equally destroyed with the former, by the other arguments used against the anastomosis or propulsion of liquors from the mother into the branches of the umbilical vein, and at the same time exposes the proposers of it to still greater difficulties. They must shew, that the sizes of the opposite vessels are fitted for such an intus-susceptio; whereas the disproportions of the human are most conspicuous, and in other creatures the chances of unfitness are much greater than those of their being rightly adapted to each other. They must name some other instance of

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any

(*a*) Fabric. ab Aquapend. de Form. Fœt. pars 1. cap. 3. Needham. Obs. Anat. cap. 2.

(*b*) Needham, ibid. et cap. 3.

(*c*) See the first article of this Collection.

any thing like this being observed any where else in a sound creature. If they take a morbid case, such as the cure of wounds by symphyfis, to illustrate their doctrine by, they would do well to consider how soon the change from contiguous to continued vessels is made there.

Were it not to prevent any good grounds for a reply, I would leave the doctrine I have advanced to be maintained by the arguments already used; but I know there are some particular observations or experiments which may be insisted on as clear evidence against me, if I do not take off their force; and therefore I will take the liberty to state such objections, with their answers.

Mr Mery (*a*) describes a child that had no heart, lungs, &c. nor nothing analogous to a heart; and therefore cannot conceive any other force that could continue the circulation of the blood in this monster, than the motion it acquired from the uterine arteries; which, according to him, must have inosculated with the placental vessels, that the liquors might be propelled through these.

Mr Mery has destroyed the necessity of his own supposition in the relation of the fact; for he tells us, That this monster was twin to a perfect child, whose *funis umbilicalis* sent off the small navel-string of the monster; and therefore the heart of the complete child would drive forwards the blood of the monster, at the same time that it promoted its own circulation, without any necessity of assistance from the mother's blood.

Mr Cowper is sometimes quoted also for supporting the contrary of what I have asserted. His words are (*b*): "These blood-vessels of the
" uterus are inosculated with those of the placenta, as may appear by the
" passing of mercury from one to the other: so that if you pour it into
" the hypogastric arteries of the mother, it will pass into the veins of the
" placenta, as well as those of the uterus; and, on the contrary, from
" the arteries of the placenta to the hypogastric veins of the mother, as
" also into the veins of the placenta. Hence it appears there is a circula-
" tion of blood between the mother and foetus; and it seems as if the
" blood-vessels of both did germinate and inosculate with each other.

But

(*a*) Mem. de l'Acad. des Sciences, 1720.

(*b*) Anatomy of Human Bodies, explic. of tab. 54. F. F. F.

“ But this requires too much speculation for my occasions to admit of a further inquiry at present.”

I imagine, that every one who reads the preceding paragraph, especially if he is at all acquainted with Mr Cowper's manner of telling what he has seen, will readily judge, that this author is there asserting rather *à priori* what he thinks would happen, than describing what he really saw upon trial. Observe only how dubious and timorous his words are: “ The inosculation may appear by pouring in mercury.—It seems as if “ the blood-vessels of both did germinate and inosculate.—This requires too much speculation to admit of a further inquiry at present.” If he had made the experiment, he would have told us, that he had poured in mercury; and, after seeing it pass in such a manner, was certain such inosculation did obtain.

Drake, who wrote after the publication of Cowper's Anatomy of human bodies, shews plainly, that Cowper never made this experiment in the human subject; for after describing a preparation which, he says, “ Mr Cowper kept by him, of a cotyledon, and part of the uterus of a cow, in which mercury, poured into a branch of the uterine artery, “ went into one of the cotyledons of the uterus, and filled those branches “ of the umbilical veins which went from that cotyledon to the navel of “ the foetus,” he adds, “ It would be a weak objection to allege, that “ the observation and experiment being made on the uterus of a cow, the “ inference would not hold from thence to a woman.” And he is obliged to make use of the flux of blood which constantly follows upon drawing the placenta from women, to prove the continuity of the vessels of the human womb and secundines. Had Cowper ever made mercury pass from the uterine into the umbilical vessels in the human subject, it would certainly have been told here by Drake, who was greatly assisted by Cowper in at least the anatomical part of his book.

Since the second edition of the Medical Essays, Dr Nortwyk has published an accurate description of an impregnated human womb, and of its contents, to which he has added an account of what authors have wrote on the different parts which he examined (*a*). In this treatise, Dr
Nortwyk

(*a*) Uteri Humani Gravid. Anatom. et historia, autore Willielmo Nortwyk, M. D. 4to, Lugd. Batav. 1743.

Nortwyk affirms, That the matter which he injected by the uterine arteries passed into the vessels of the chorion and placenta, which he is ready to demonstrate at any time in the preparation which he preserves.

Such a positive assertion of an anastomosis, or of a continuity of the vessels of the womb and secundines, by a gentleman of so much learning and candour as Dr Nortwyk evidently appears to be, has made several considerable men to decide against me; and to affirm, upon his authority, that there is an anastomosis. But upon comparing his description with my dissections of big-bellied women, I think it altogether evident, that a mistake of the doctor in the dissection has led him into conclusions directly contrary to what I am persuaded he will make when the mistake is pointed out to him. That every one may judge for himself, I shall here first set down his descriptions of these parts; then I shall mention what I remarked in my dissections; and, lastly, I shall point out the circumstances in both, from which the conclusion must be drawn.

“ Dr Nortwyk was surpris'd that he could not recline over the cut parts of the womb. Inquiring into the cause, he saw the chorion grown to the womb by a true but very soft cellular substance; by means of which the whole surface of the ovum adhered most strongly to the womb, so that no mark of division appeared when the substance of the womb was rais'd. Having softly depress'd the ovum with the back of a knife, and moved the knife backwards and forwards (reciprocato) betwixt the ovum and uterus, that connecting substance was most easily broken (*a*).

“ Numerous injected vessels with very thin coats were seen in this cellular substance, stretch'd from the chorion into the womb, which he calls vessels of the two parts joined by anastomosis, and believes them to be veins (*b*).

“ The larger branches of these vessels were remarkably dilated within the substance of the chorion into twice their former capacity, forming sinuses; and in this form were extended an inch, then dividing into branches sank deeper into the chorion (*c*).

At

(*a*) Uteri Anat. § 6. N° 1.

(*b*) Ibid. N° 2.

(*c*) Ibid. N° 3.

“ At the placenta the cellular substance was stronger, and the connection greater, with vessels likewise extended through it (*a*).

“ At the root of the placenta there were numerous very large vessels capable of admitting a child's finger; they were true venous sinuses made of very thin coats and short, from which branches much smaller, mostly very small, sunk into the placenta, and in some places penetrated to its basis, where it lies on the chorion (*b*).

“ There were no vessels in the womb of equal size, and corresponding to these sinuses; which surprised him, having seen vessels of a womb of a new-laid woman dissected by professor Albinus, and of one dissected formerly by himself, so large, that an adult person might almost have put his finger into them (*c*).

“ The whole internal surface of the womb had many orifices of vessels filled with the injection (*d*).

“ The surface of the ovum was all shaggy, because of the remains of the cellular substance (*e*).

“ The chorion was opaque, soft, fungous, and so very tender as to be easily torn (*f*).

“ Under this fungous there was a reticulated substance (*g*).

“ The fungous and reticulated substances separated most easily from each other (*h*).

“ Placentæ extracted after child-birth, when injected, ended in pulpy knots; which, macerated, shewed themselves to consist of very small vessels of the pencil form (*i*).

“ The injection into the impregnated womb did not penetrate into the foetus or umbilical rope (*k*).

“ On the side of the placenta farthest from the womb, the red colour of the injection shined through the chorion; and in one part where the chorion was taken away, the small injected vessels were to be seen in the preparation (*l*).”

Thus far Dr Nortwyk gives an account of his dissection, &c.

I have now dissected five women who died each with a child in the womb,

(*a*) Uteri Anat. § 7. No 1.

(*b*) Ibid. No 2.

(*c*) Ibid. No 3.

(*d*) Ibid § 9. No 1.

(*e*) Ibid. § 11.

(*f*) Ibid. § 12. No 1.

(*g*) Ibid. No 2.

(*h*) Ibid. No 3.

(*i*) Ibid. § 28. No 2.

(*k*) Hister. Uter. pars 2. § 83.

(*l*) Ibid..

womb, before either the membranous part of the secundines was torn to let out the water, or that the placenta was the least separated from the womb. One of them was said by the friends to have been between three and four months gone with child; three others were about six or seven months, and the fifth was past eight months, gone with child. I likewise examined the body of a sixth woman, whose child in the labour had torn the *os uteri*, and by the aperture had escaped into the cavity of the abdomen, dragging its secundines along with it. In all of them I found a thick, fungous, succulent, cellular substance between the muscular part of the womb and its villous coat, through which numerous thin-coated vessels passed; and in this cellular substance the sinuses were. Excepting its sinuses, it resembled the internal cellular coat of the intestines.—I was ignorant of this structure when I began the dissection of the first bigbellied woman; and therefore, when I had cut through the firm muscular part of the womb, and saw this fungous substance, I imagined it to be the placenta. I was surprised to find the cohesion of this supposed placenta to the womb so firm; but persisted to separate the muscular part of the womb from it, till, having torn a little of the fungous substance, I observed the smooth tense chorion, from which the fungous substance separated most easily, as it did likewise from the placenta, by only gently pressing the ovum with one hand, and raising the womb with the other, without the assistance of any other instrument. What of the fungous substance had been left at first with the ovum came off as easily.—I avoided this mistake in dissecting the other four impregnated uteri which I had occasion to examine afterwards; and then had the villous coat of the womb entire, and the smooth chorion spread over all the secundines.

Let the following circumstances be considered.

1. The firm adhesion of the uterus to the ovum as described by Dr Nortwyk; whereas in natural births, and in my five subjects, the womb and secundines separated most easily.

2. The want of sinuses, or of vessels a-kin to them in the womb, which gave rise to his treatise; whereas the sinuses were demonstrated by Dr Albinus, and they were seen by Dr Nortwyk himself in the womb of a woman lately delivered, and they were found in all my six subjects.

3. The shaggy surface of the ovum, and the soft fungous opaque chorion described

described by the Doctor; whereas the chorion in natural births, and in all my subjects, was smooth, firm, and tense.

4. The separation of the fungous substance on the surface of the ovum mentioned in this section was as easy, as what I found the separation of the womb from the ovum.

5. Large sinuses were found by Dr Nortwyk in the placenta and chorion, which never were seen in these parts of any other subject.

From these circumstances I must think, that the Doctor persisted in the error which I committed in dissecting the first impregnated uterus which I had occasion to examine, and brought off the internal cellular substance and sinuses of the womb with the ovum, in which case all the appearances would be precisely as he has described them; and he will be under no necessity of imagining some particular form of vessels here, or any extraordinary change of structure made in placenta by extracting them at birth; on the contrary, the reasons of all the phenomena are obvious, and he has afforded me a very pretty proof of their being no anastomosis between the vessels of the uterus and secundines.

Left the last paragraph which I quoted from Dr Nortwyk should make any incline to think, that, in his preparations, some of the placental vessels were injected, I must explain the appearances there mentioned, which I shall do by the assistance of the Doctor himself. “The placenta, says he justly, (§ 15. 28.) consists of a great many knobs, between which the membrane (the exterior lamella of the chorion) is inserted, as the pia mater is between the convolutions of the brain; and the soft spongy internal substance of the womb is insinuated into the furrows between these knobs.”—No wonder, then, that the uterine vessels filled with a coloured substance shine through the chorion on the other side of the placenta, or are seen when the chorion is taken away. Let us remember this when we read any where, that injections into the uterine vessels *placentam subibant*.

To Dr Nortwyk's experiment in proof of liquors not going from the uterine vessels into those of the secundines, I shall add a trial which I made of injecting these parts of a woman three or four months gone with child. Having fixed a pipe into one of the iliac arteries, and having tied the other iliac artery and the veins, I pushed through the pipe fine oil

of turpentine, which is a liquor that easily goes from the extreme arteries of any part of the body into the corresponding veins. I continued this injection till all the vessels of the womb, both arteries and veins, were in hazard of bursting, and till all the gentlemen present agreed, that a sufficient quantity and force were employed. Not one drop of this oil was found in any branch of the umbilical vessels or in the foetus, though it was searched for most carefully.

Dr Nortwyk is of opinion, that nothing can be concluded against the anastomosis of the vessels of the womb and secundines, from the experiment just now related: For, (says he), (*a*), "Injections do not always pass where there is a continuation of vessels: thus, for example, Ruyfch (*b*) informs us, that though he filled numerous branches of the spermatic artery running in the interstices of the feminal tubes, and also the smaller lateral branches of arteries bestowed on the tubes; yet he never could make his injection enter the tubes, notwithstanding that De Graaf (*c*) describes these tubes as ten times larger than the injected arteries."

If the feminal tubes were of the size described by De Graaf, where they begin at the extremities of the fecerning arteries, and these extremities were no smaller than the arteries which Ruyfch injected some application might be made of this example to the present case: but seeing the spermatic arteries may divide, for ought we know, into branches not one millionth part the size of those which Ruyfch injected, before they became feminal tubes; there is no other inference to be drawn from this quotation from Ruyfch and De Graaf, than that the spermatic arteries divide into branches, before they become feminal tubes, too small for Ruyfch's injection to enter.—If the spermatic arteries had been as large at their extremities as what were seen in the internal surface of the womb in Dr Nortwyk's preparation, and if the feminal tubes had been as large at their beginning as what he calls *placental vessels*, I make no doubt that Ruyfch's injection would have filled the larger feminal tubes, *epididimis vas deferens*, &c. as Dr Nortwyk's injection ought to have filled the
umbilical

(*a*) Hist. Uteri Gravid. pars 2. § 83.

(*b*) Thef. Anat. iv. No 8.

(*c*) De Viror. Organ. p. 43.

umbilical vein, and several of the vessels of the foetus, had it once entered into such large branches of that vein as he imagined.

Let us next examine the trials made on brutes for proving the anastomosis or continuity of the vessels of the womb and secundines.

I have already transcribed Dr Drake's account of Mr Cowper's "having poured mercury into the uterine artery of a cow, that went into one of the cotyledons of the uterus, and filled those branches of the umbilical veins which went from that cotyledon to the navel of the foetus."

Mr Cowper (*a*) mentions some other preparations of the same parts in cows, but takes no notice of this one; and Drake expresses himself so little like an anatomist in comprehending both the glandula of the womb and the placenta of the secundines under the name of *cotyledon*, that I suspected his having committed a mistake here: and therefore I repeated the experiment many times, by pouring mercury sometimes into a branch of the uterine arteries distributed to one of the glandulae, and at other times I poured the mercury into a branch of one of the umbilical arteries sent to a placenta, but never could make one drop of it go from the vessels of the one into the vessels of the other. The weight of the mercury frequently makes the glandula and placenta separate from each other, and then the foveae of the glandula and the interstices of the papilla of the placenta have quicksilver lying in them; but none of it is to be seen in any thing like a vessel of the placenta when it is poured into the artery of the womb, or of the glandula when it is poured into the umbilical artery.

Slade is quoted (*b*) for saying, "The placentulae of cows have more and larger vessels than the cotyledons; and if a black liquor is injected into the artery which is sent to a placenta. the cotyledon remains white. The liquor injected into the arterious vessels of the uterus was carried to the cotyledons, and by the cavities of the cotyledons into the substance of the placenta."

These words being *carried into the substance of the placenta*, may signify no more than effused on their unequal pappy substance. I have tried injections of very different kinds so often into the vessels of the womb and

3 C 2.

secundines

(*a*) Anatomy of Human Bodies, explic. of tab.

(*b*) Vid. Blaf. Anat. Animal. p. m. 122.

secundines of cows, prepared in all the different ways I could contrive for making liquors pass from the one to the other, without having once made a drop to pass, that I cannot be more certain of any thing than that there is no anastomosis or continuity of these vessels in cows.

Vieussens is said to have made the following experiment (*a*): “ He tied the left carotid artery of a living bitch with young ; and then, having put a small ivory funnel into the right carotid, he poured quicksilver at different times towards the head, till it amounted to about four pounds. By the time this quicksilver was poured in, the creature appeared to be quite dead, and he dissected her before a great many witnesses.” After describing the progress which the quicksilver had made in the vessels of the bitch, he has these words : “ *Mirum dictu ! Fluidum hocce corpus, nullo rupto vase, et ne una quidem gutta sanguinis effusa, placentam unumquemque catulum obvolvntem permeavit, et in ipsas umbilicales venas protrusus fuit : Ipsummet fluidum cavitates cordis, stomachi, vesicæ felleæ, intestinorum, et vesicæ urinariæ, ingressus est. Protrusus à me in arteriam carotidem dextram mercurius, in arterias, et subinde in ductus lactiferos mammarios, sese immisit, ut supra indicavi.*”—No more of this description relates to the foetus than “ That fluid, (the mercury), without breaking any vessel, or the effusion of one drop of blood, passed through the placenta surrounding each whelp, and was pushed into the umbilical vessels themselves ;” all that follows about the heart, stomach, &c. being only applicable to the mother’s organs, as appears by the reference to what he had said above, where the parts of the mother only were mentioned, and by the account which he gives of this experiment in another treatise (*b*) in these words : “ Mercury being poured into the right carotid artery of a bitch about two months gone with whelp, the left carotid being tied, passed into the umbilical vein of the whelps without any breaking of the vessels.”

This experiment of Vieussens’s is strangely contrived ; for, by tying one carotid artery, and putting a funnel into the other, he left the vertebral arteries

(*a*) Manget. *Theat. Anat.* lib. 2. cap. 3. Excerpta à Raymundi Vieussenii epistol. ad excell. Prof. celeb. Medic. Facult. Patav. et Bonon. in Genevensi Verheyenii editione.

(*b*) *Dissertat. de structura et usu uteri et placenta muliebris*, in Genevensi Verheyenii editione.

arteries alone to propel the blood and quicksilver through the vessels of the head, from which they were to return to be distributed through the whole body.—Some of the blood of the vertebrals must have had a retrograde motion into the carotids by their anastomoses, to hinder the entry of the quicksilver.—If the head of the bitch was placed so depending, as the weight of the mercury could overcome the resistance of that blood, which probably has been done; then this ponderous liquor must have passed through the tender very small arterious vessels of the brain, and have ascended in the veins, contrary to its own gravity, to come to the heart; after which it must have performed the circulation through the heart and lungs to be sent into the aorta, from which it behoved to be pushed through the vessels of the womb into the secundines.

I endeavoured to imitate Vieussens's experiment on a living bitch, but the creature died before any success could be expected; and therefore, with the assistance of my colleague Dr Andrew Sinclair, P. M. and of Mr Gibson, I took another way to try if the mercury would pass from the womb into the umbilical vessels. I cut as much of the teguments of the neck of a pregnant bitch immediately dead, as to have a view of as much of the carotid artery as I could open and put a pipe into; then hanged the bitch by the neck higher than where the pipe was; and, in this posture, poured in the quicksilver, by which we prevented the mercury's running out at cut vessels, and gave it the pressure of a very high column to make it run further into the vessels than it would have done otherwise. The quicksilver soon ran plentifully out at the vagina, the orifice of which was then tied, and more mercury was poured into the carotid, till all of us agreed, that, if there was any anastomosis or continuity between the vessels of the womb and secundines, the mercury must have passed from the one to the other. When we opened the bitch, we saw the vessels of the uterus and of its cornua very turgid with quicksilver. The body of the uterus and the right cornu contained no foetus, but were distended with extravasated quicksilver. There was one whelp in the left cornu, which we tied above and below where the foetus was lodged, then cut it out and laid it on a plate.—When this cornu was cut longitudinally, the annular placenta separated most easily from it; and, as we were separating them, the mercury ran plentifully out of the vessels

fels of the cornu, but not a drop of it appeared in, or dropped out of, any vessel on the exterior surface of the placenta or of the chorion.—After the amnios was opened, there was no mercury to be seen in the fœtus or in the umbilical vessels, though we could trace these to their very minute branches in the placenta and membranes. When the secundines had been handled some time, and the amnios was turned outermost, some exceeding small and short streaks of quicksilver appeared under that membrane; but, not being contained within any thing like the coat of a vessel, Dr Sinclair and I judged them to be no other than some drops of the mercury, which we had seen stick to the outer surface of the placenta, when they fell from the cornu, that had been pressed by handling into the small interstices of the placental substance; and therefore concluded that no mercury had passed from the uterus into the umbilical vessels.—I repeated this experiment in a bitch that had five whelps in her cornua, without one drop of quicksilver being seen in any vessel of any of their secundines, though both arteries and veins of the uterus and cornua were full of it. I designedly dropt some quicksilver on one of the placenta; and then worked it in with my fingers, till I formed such streaks as we had seen in the former trial, which I verily believe was all that Vieussens saw. Though, if we would grant, that some of the quicksilver in his experiment had entered the branches of the umbilical vessels, or even though the mercury had been found in the whelps, it would be no proof of the anastomosis or continuity of the uterine and umbilical vessels: For since, according to him, the bitch was alive, till, at different times, near four pounds of mercury were poured in, (*credat Judæus*), the placental vessels might have absorbed the quicksilver.

Would a man, who believed that the above experiment showed an anastomosis, write in the following manner as Vieussens has done (*a*)? “It is observed, that quicksilver injected into the arteries of the womb, does not run into its cavity, unless when its substance is strongly pressed with the fingers; for then some parts of the mercury fall into the womb by the pores of the lymphatico-arterious canals that form its substance.” And again (*b*), “The effusion of blood at birth, without doubt, was also the cause why several old anatomists, who were little acquainted

(*a*) Differt. de Structura et Usu Uteri, &c. § 51.

(*b*) Ibid. § 56.

“ acquainted with the natural œconomy of the human body, yea and Mr
 “ Mery, believed that the arteries of the womb directly opened into the
 “ veins of the placenta, and that the arteries of the placenta opened into
 “ the veins of the womb; from which they concluded, that the mother’s
 “ blood circulated into the body of the foetus, and that the blood of the
 “ foetus passed into the mother’s body. But the falsity of this opinion,
 “ which was refuted by many anatomists of the last century, who were
 “ not only skilful dissectors, but very learned natural philosophers, shall
 “ be most evidently demonstrated from what I am to say, when I explain
 “ the internal structure and the use of the placenta; so that the abettors
 “ of it will readily reject it.”

I have sometimes seen quotations from Preston (*a*) and Heister (*b*), for experiments proving this disputed anastomosis; but there are no such experiments mentioned in either of them. Preston tells only that he saw,
 1. Air pass from the umbilical vein into the umbilical arteries. 2. Air, and an injected liquor, forced into the hypogastric arteries of a woman newly brought to bed, made their way into the cavity of her womb.
 3. An injection into the umbilical vein of a foetus, which filled both its veins and arteries.—Heister has nothing but what I have already taken notice of.

Though I think this § 16. sufficiently proved; yet, to shorten hereafter the dispute concerning the nourishment of a foetus, I may remark, that it will be sufficient for my purpose in the present question, to have part of the vessels of the secundines granted to be absorbents, (the negative of which, I dare affirm, nobody will undertake to prove), though others were found to be continued or to inosculate with those of the uterus.

17. The red particles of the blood are not probably absorbed by the small extremities of the umbilical vein.

My reasons for thinking so are: The smallness of the orifices of these vessels (§ 9.); the chylous appearance of what is separated by the glandulæ of cows and sheep, though the extremities of the vessels of their placentæ are larger than in the human subject (§ 12.); and the want of an example of red globules being absorbed any where else.

If

(*a*) Philos. Transact. Lowthorp’s Abridg. vol. iii. p. 210.

(*b*) Compend. Anat. not. 36.

If it should be asked, Whence then has the foetus red blood? I answer, without entering upon any philosophical comparison of the placenta in a foetus, and of the lungs in respiring animals, That foetuses of viviparous animals have their red blood from the same source that chickens in ova have theirs; which can be no other than the action of their heart, and of the vessels in their body and secundines.

If it should be further objected, That the instances mentioned (§ 13.) of children being exhausted of blood by hæmorrhages from the mother's vessels, shew the red globules to be sent out from the secundines into the uterus, and therefore probably such are taken in; the answer is ready, viz. That these instances prove the loss of such red particles no more than the wan colour, faintness, and the emptiness of the vessels, in a violent diarrhœa, are certain signs of bloody stools; which none will affirm they are.

18. The placenta does not increase in the same proportion which the foetus does; for the smaller the foetus is, the placenta is proportionally larger (*a*).

19. The smaller share by far of the blood sent out by the umbilical arteries, is returned to the uterus, most of it being poured into the umbilical vein by anastomosing canals.

This may be seen by injecting liquors into the umbilical arteries of any creature. Rouhault (*b*) calculates, that only one seventh part of the capillary branches of the human umbilical vessels reach the exterior surface of the placenta.

20. The progressive motion communicated to liquors by the power of absorption being slow, and no external alternate pressure having a considerable effect in increasing the momentum of the liquors moving in the vessels contained within the uterus, it would appear that the blood returning to the foetus is pushed forward principally by the force of the heart and arteries of the foetus itself.

That the force of the heart may be strong enough to drive forward the blood in such a long course as it must make in the secundines, the *canalis arteriosus* is sent from the pulmonary artery into the descending aorta, whereby

(*a*) See the figures in Ruyfch, thesaur vi. Heister, fig. 27.

(*b*) Mem. de l'Acad. des Sciences, 1715.

whereby the blood thrown out by the umbilical arteries is propelled by the united force of both right and left ventricles of the heart; and these arteries anastomose with the branches of the umbilical vein by larger communicating canals than the arteries and veins commonly have in other parts of the body, as appears by injections: for liquors thrown into the umbilical arteries towards the placenta, require less force to make them return by the umbilical vein; and when injected with the same force, they return more quickly than they do into the vein corresponding to any other artery of a child when the artery is injected.

21. In the greater number of animals that have hitherto been carefully examined, the allantoid membrane, with its contained urine, has been found (*a*).

22. The allantois of some animals (mares, bitches, cats,) surrounds the amnios, being every where interposed between it and the chorion. In others, (cows, sheep, goats), the allantois incloses a considerable share of the amnios. And in others, (swine, rabbits), it is confined to a small space (*b*).

23. At those places where the allantois is not interposed between the other two membranes of the foetus, the chorion adheres to the amnios by a very fine cellular substance, which easily yields to any stretching force, as every one must see in examining the secundines.

24. The amnios has numerous ramifications of the umbilical vessels spread upon it (*c*); the orifices of the lateral branches of the arteries pouring out liquors into its cavity.

Injections plainly discover this. For after injecting a thin liquor, water for example, into the umbilical arteries, dry the interior surface of the amnios well with a cloth: then press the membrane gently, or continue the injection; and the water is seen coming out on that surface, in the form that we see small drops of perspirable matter come out on the surface of the skin at the finger-points when we press the finger hard or have tied a string round it. I have many times repeated this experiment, and always with success.

25. Seeing we can demonstrate veins also on the amnios, and seeing the

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(*a*) Needham, *Observ. Anat. de Form. Fœt.* cap. 3.

(*b*) *Id. ibid.*

(*c*) *Id. ibid.* Cowper's *Anat. of Human Bodies*, expl. of tab. 59, A. A.

the veins of all other membranous bags that have arterious canals throwing liquors into their cavity are endued with an absorbing power, and take up fluids from the cavity, we may conclude, that the veins here are the same way employed.

26. The liquor contained in the amnios is either wholly separated from the vessels of that membrane; or it is furnished partly from them, and in part from the foetus.

In the creatures whose amnios is every where inclosed by the allantois (§ 22.), it is impossible this liquor can be transcolated from the uterus or its cavity through all the membranes into the cavity of the amnios; because, if the allantois could allow a passage to such a fluid, its own contents would necessarily go along with it, which every one would confess would be of bad consequence: but the truth is, that the allantois does not allow liquors to pass through it. In those creatures where the allantois only surrounds part of the amnios, if we did suppose the chorion and amnios capable every where else of serving as strainers, the liquor would always be found in considerable quantity in the cellular substance between them (§ 23.); which it is not: and what should hinder it to run out as fast as it could be conveyed in?

Let none here assume canals having orifices opening on the surface of the chorion, and sent directly into the cavity of the amnios, unless he undertakes to demonstrate them. There can be no such canals in the creatures whose allantois surrounds their amnios; for there are no threads extended cross the allantois.

Harvey's observation (*a*) of this *liquor amnii* being seen in a large quantity before the foetus is formed, may probably be objected to me as a sure argument of its being derived from somewhere else than the umbilical vessels, or surface of the foetus; and that can only be from the cavity of the uterus by transcolation.

Harvey's assertion is only this negative, That he did not see a foetus in the very small conceptions he examined; but it is very evident from later observations (*b*), That the rudiments of the foetus, and its *funis umbilicalis*

(*a*) De Generat. Animal. exercit. 56.

(*b*) Compare Harvey's exercit. 15. 16. 17. with Malpighius *de ovo incubato*, in the first three or four days of incubation; and his exercit. 56. with Kerkring. Anthropogr. Ichnogr. and Ruysch, Theat. 6. and many other later observations.

lis, may be seen much sooner, and while the conception is less than what he determines it to have been in the cases where he says he could not see it: and, in my opinion, extra-uterine foetuses prove clearly, that the embryo is always lodged much sooner in its secundines than we can discern the different parts of these; far less need we expect to be able to distinguish the different parts they contain. I shall readily allow that the *liquor amnii* is in larger proportional quantity the younger a conception is: And the reason of this appearance may very easily be understood, from what was said concerning absorption (§ 15). From the observation itself, compared with what is above in this section, I would infer, that the vessels of the amnios furnish by much the larger share of the liquor contained in it.

Whoever considers the large placenta (§ 18.), the quick growth (§ 32.), and the weakness, of a young foetus, will not affirm its being incapable of furnishing this liquor of the amnios.—The vesicles full of water, in which there is no foetus, and consequently no placenta, when found in the womb, cannot be esteemed to be ova, but are hydatides, of which great numbers are often found here (*a*); and therefore serve nothing for determining the present question.

N. Authors having differed widely concerning the quantity and quality of the *liquor amnii*, and my observations not having been universal enough to fix a general rule, I shall delay any inquiry into the state of this liquor, till I come to examine it as it is employed in accounting for the nutrition of a foetus; where I shall consider it, according to all the different opinions of authors.

27. As soon almost as we can observe any embryo, its umbilical vessels discover themselves (*b*).

28. The mouth, lips, and cheeks of foetuses, are at first wanting, and leave a large chasm instead of a mouth; which is gradually contracted by the formation and conjunction of these parts, till it is brought to a due size (*c*).

29. While foetuses continue in the womb, their muscles are ordinarily

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left

(*a*) Vid. Hist. in Haller. not. m. in § 679. Institut. Boerhaavii.

(*b*) Harvey, exercit. 56. Ruysch, Thef. 6. Riolan. Anthropograph. lib. 6. cap. ult.

(*c*) Harvey, *ibid*.

left to act only by their natural contraction, or the foetus is said to be in a sleeping state; but sometimes, when its ease or preservation requires a change of situation, it seems to perform some voluntary motions, which are called its *firrings*.

The posture of a child is owing to the muscles being left to their natural contractions, the stronger ones always prevailing, till their antagonists exert such a resistance by being stretched as brings them to an æquilibrium. No wonder, therefore, that the spine is so much bowed forward, and the head is bended towards the knees; the thighs are brought forward; the legs are bended back; the arms hang down, but are drawn a little forward; the fore-arms, hands, and fingers, are all bended, and thereby the hands are placed round the knees: For it will appear to any who shall take the trouble to consider the structure of these parts, that the members are all brought to that side where the muscles have an advantage over their antagonists in number and strength, or in the angles of insertion, or in the length of the lever they act with.

That the posture above-described arises from the natural contraction of the muscles, while the foetus is in a sleeping state, is farther evinced, by observing how much children sleep after they are born, and how the members naturally go into near the same posture when people fall asleep.

30. The stomachs of the youngest foetuses we can dissect are full of a mucous liquor, which remains of near the same consistence all the time of gestation, except that it becomes gradually somewhat more viscous as the foetus increases.

This has obtained in all the different animals I have had occasion to dissect.

31. The small guts of foetuses are full of a glairy mucaginous liquor, which becomes thicker and darker coloured as it descends to the great guts, where it is collected under the name of *meconium*.

32. Foetuses increase proportionally less the longer they continue in the womb.

Mauriceau (a) pretends to determine the proportional increase of a child

(a) De maladies de femmes grosses, liv. i. chap. 5.

child to be sixty-four times its own weight in triple the time. The numbers he condescends on are the following: At birth, a child weighs 12 pounds, of 16 ounces each; at three months, it weighs 3 ounces; at one month, three fourth parts of half a drachm; and at ten days, less than half a grain.

Having now established the necessary facts, I design to use them hereafter as so many axioms or data; and, to save repetitions, I shall only refer to them by the numbers prefixed to each, in the solution of the several problems, to which I now return.

PROBLEM I. *How far the Mouth or the Umbilical Vessels are necessary to the Nourishment of the Fœtus.*

AUTHORS have all known that fœtuses have been brought forth without mouths: but several of these monsters being found, upon a strict examination, to have some other passage leading from the surface of their bodies into their stomachs, several writers of good account have affirmed, or at least in an indirect way have insinuated, that such vicarious passages are never wanting when the mouth is shut or deficient; which they think rather a stronger proof of the ordinary canal by the mouth in complete fœtuses being altogether necessary for the nourishment of the fœtus, than if no such monsters had been seen; since, say they, we hereby see how careful nature is to preserve a passage from without into the chylopoietic organs.

To remove all pretences for concluding hereafter so generally that a vicarious passage is never wanting, allow me to point out some authors, who give accurate and well-vouched histories of monsters who had no such canals, and in some of which it was impossible they could have them, or they must have been altogether useless.

Children (a), a whelp (b), and a lamb (c), were brought forth without heads, or any passage into the chylopoietic bowels. In other fœtuses that had heads, all passage to the stomach was shut up: See such observations of

(a) Two by Littre, Mem. de l'Acad. des Sciences, 1701; one by Mery, ibid 1720.

(b) De Graaf, de Mulier. Organ. cap. 15. (c) Antoine, Hist. de l'Acad. des Sciences, 1703.

of children (*a*), of whelps (*b*), of a lamb (*c*), of a pig (*d*). Where the passage into the stomach has been open, there have been no intestines (*e*); and, where the guts were, nothing could get down into them (*f*).

These examples are so exact in showing the little necessity there is for either mouth or chylopoietic organs in the nourishment of foetuses, that I need scarce mention how much they serve to determine the first part of this problem; and they make remarks on the histories of foetuses, who had the vicarious passages, unnecessary: only allow me to caution the young physiologists, not to take some authors assertion, of the food being conveyed by those extraordinary canals, for an established truth, till they have examined what is to be said for and against it.

Though the former part of the problem should be determined in the manner I have argued for, which takes away all probability of nourishment being furnished to foetuses by the mouth alone; yet the gentlemen who are of opinion that it is conveyed by both the umbilical vein and the mouth, endeavour to resolve the latter part of it so as still to favour their sentiments: for they undertake to prove, that the supply by the navel may be wanting, as well as that by the mouth; and therefore, that both contributing towards the nourishment in the natural state of the foetus, whenever one of them is wanting, the other performs the function of both, as is sometimes done in other parts of the body. I acknowledge great probability in this reasoning, if they can bring a clear convincing proof of foetuses subsisting and increasing without receiving liquors by their navel-string. Seeing, then, this part of the problem is of such importance in the present question, I must be excused for insisting particularly on the several facts which I have observed to be advanced by authors in proof of the navel not being indispensably necessary toward the nourishment of a foetus.

The first argument used by the gentlemen of the other side of the question,

(*a*) Littre, Mem. de l'Acad. des Sciences, 1701. Buchnerus, Act. Med. Physic. Acad. n. c. vol. ii. obs. 96.

(*b*) Littre, Hist. de l'Acad. des Sciences, 1703. Brady, Philos. Transf. n. 304.

(*c*) Ruysch, Thef. 4. n. 55.

(*d*) Bellinger. de Fœt. Nutr. cap. 9.

(*e*) Lemery, Hist. de l'Acad. des Sciences, 1704.

(*f*) Calder, Medical Essays, vol. i. art. 14.

tion, is, That authors of the best character (*a*), who have dissected viviparous animals with young, assure us there is no adhesion or connection between the secundines and uteri of most animals, for a considerable time after the conception is lodged there; and, in some animals, many months pass before there is any adhesion (*b*): therefore, say they, the foetus can receive nothing all this time from the mother by the umbilical vessels; and consequently is then wholly nourished by the mouth.

On the supposition that the uterine vessels must always inosculate with those of the secundines, before the umbilical vessels can receive any liquors from the mother, this argument is indeed of great force. But according to the scheme which I have explained, and, I hope, have proved in § 16. & 17. of preliminary facts, it is a matter of indifference, whether the liquors furnished by the mother are applied to the bibulous orifices of the absorbent vessels of the secundines, while the liquors are contained within cells formed in the substance of the uterus (§ 2.—5.), or when they are poured into the cavity of the uterus itself: for those vessels will equally well perform their office in both cases, and thereby serve to nourish the foetus sufficiently; which must take off the necessity we were here imagined under, of supposing the food to be wholly received at the mouth. Nay, in some animals, for example mares, whose allantois surrounds the amnios (§ 22.), and whose secundines have no connection for a considerable time with the uterus, what has been just now said is finely illustrated; and there is downright demonstration of all the foetus's nourishment being conveyed by the umbilical vessels, as was remarked § 16.

Next, several observations are brought to show, that the passage of liquors by the navel has often been stopped long before birth. The first I shall mention is one of Mr Petit (*c*): “Mr Petit (says the secretary of the Academy of Sciences) caused the navel-string of a human foetus to be shewn, which had a knot in its middle, where one could observe the marks of the contiguity (*d'attouchement*) of the parts that formed the knot; which proves that the knot had been made long before the woman's delivery.”

It may be said, that this is in some measure answered by what Mauriceau

(*a*) Harvey, Needham, de Graaf.

(*b*) Needham, Obs. Anat. de Form. Fœt. cap. 2.

(*c*) Hist. de l'Acad. des Sciences, 1718.

ceau (*a*), Deventer (*b*), and other practical writers in midwifery, affirm of the danger children are in of losing their lives when the umbilical rope is pressed or exposed to the cold air before birth, and by observations of foetuses being killed by knots on the navel-string (*c*). But the fact, as it is told, is open to strong objections; for there is not one circumstance mentioned by which we can know whether this knot stopped the course of the blood, or if it was any more than one of the common ones, about which some midwives make so much to do. I have given a figure of one, serving to show, by my injection passing, that liquors will not stop in such. See Plate I. fig. 5. "representing a piece of the funis umbilicalis, whose vessels are distended with wax." AA is the large vein; BB, the two arteries twisting spirally round the vein; C, a very remarkable convolution of the arteries, which resembled a knot, before the injection was thrown in.—Further, I see no reason to conclude from Mr Petit's observations, as the secretary has done, that because there were marks of the parts which composed the knot, touching, or being contiguous to each other, therefore the knot must have been of an old standing. Add to all this, that there is no mention made of the child's condition, whether it was born dead or alive. So that, from the whole, I must think there can be no use made of this observation in this argument. And I must also acknowledge, that the observations of children said to be killed by knots on the navel-string, are as little to my purpose: for though the authors who relate them, do aver the knots to have been the cause of death, yet they do not mention circumstances in the fact sufficient to support their opinion; for which I must decline the greatest authority, though it were ever so favourable to my side of the question.

The second observation brought to prove the course of the blood interrupted in the umbilical vessels before birth, is what Mr Heister (*d*) quotes from Fred. Hoffman's Dissertation *de pinguedine*. Unluckily that treatise is not among the collection of Hoffman's Dissertations I am possessed of; and therefore I must take the relation of the fact at second-hand. It is this: "A perfect child was born, whose umbilical rope was all corrupt
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(*a*) *Maladies des femmes grosses*, liv. ii. chap. 26.

(*b*) *Ars Obstetric.* cap. 38.

(*c*) *Ruyfch. observ.* xi. Gutterman. in *commerc.* Norimberg. 1731. semest. 1. spec. 20.

(*d*) *Compend. Anat.* not. 37.

“and putrid, (*putredine totus corruptus erat.*)” Mr Heister adds, “It would have been impossible that it should have lived, unless it had taken its nourishment some other how than by the navel.”

Though, for ought that is expressed here by either Hoffmān or Heister, it seems to be ambiguous, whether this complete child was born dead or alive, yet I shall suppose the latter case: and, when this is granted, the account is such as one cannot pretend to guess from it how long this navel-string had been corrupted; what parts had been destroyed by the putrefaction; whether the cellular membrane and mucus of the rope only were affected, or if the vessels involved in them were also destroyed. In short, this story does not seem distinct enough to allow any consequence to be drawn from it. Left, however, any should build on a strict sense of the word *TOTUS*, which ALL the world knows is generally used in a very vague way, let such reconcile any appearance of a *funis umbilicalis* with the total and complete corruption of the membranes, mucus, and vessels composing it.

The two following histories are much more exact and to the purpose. One is from Chatton (*a*); the other is told by Petrus Rommelius (*b*). Both agree almost exactly in the principal circumstances. Healthy children are born with the navel skinned over. The secundines, when afterwards brought away, are of a natural size, and the extremities of the umbilical rope are coalesced. The mother of the one told Mr Chatton, that she had gone with child three weeks longer than her ordinary time; and he thinks the navel was as found as a child three weeks old used to have it. Rommelius judges the other child's navel to have been as found as in children several months old. A little impervious process about the size of a worm stood out from the navel, and the umbilical rope was as small as a goose-quill.

These authors have been very fond of setting the world a-staring, otherwise they would never have made the comparisons of the soundness of the navels of the children in their histories with those of children so many weeks or months old. I wish they would explain to me what is the difference as to soundness in a sound navel of children three days, weeks,

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months,

(*a*) Vander Wiel, *Observ. Cent. Post.* pars 1. not. in obs. 32.

(*b*) *Ephemerid. German.* dec. 2. ann 7. obs. 209.

months, or years old. Since there is none, we are to inquire how long time these navels had probably been in skinning over after the navel-string was broke or eroded. The circumstance of the secundines being of a natural size, shews that this accident did not happen long before birth; for from what was said in § 14. of the placenta being a lifeless mass after the communication betwixt it and the child is destroyed, and from what the best and most experienced practisers in midwifery (*a*) agree in, the size and state of the after-burden must be greatly changed in very little time after it is in that lifeless state which must be here supposed. The only way of judging in what time a skin might be brought on the navel of the children mentioned in the foregoing histories, is to determine, How soon after birth childrens navels are skinned over; and then to inquire, Whether a cicatrice would be sooner or later brought on by the child's continuing immerfed in its waters after the navel-string was broke. I have frequently seen, and among the rest in my own children, the tied piece of the navel-string fall off, in four, three, or two days after birth, and the skin was found where the shrivelled string separated: And it is generally known how very soon the remains of the navel-string drop off from brutes. If then such a separation can be made so soon, when dry rags are applied, or by being exposed to the air, we have reason to think that the skin would be much sooner brought on the navel while the parts were soaking in the *liquor amnii*: for we have very convincing proof what the effects of such a salt liquor is in the saliva, which not only serves to keep the mouth soft and flexible, but very soon heals wounds or mild abscesses there; the urine will scarce allow surgeons to keep the wound in lithotomy long enough fresh, but, notwithstanding their utmost efforts, it often renders the passage callous. The synovia of the joints, the glary liquor of tendinous or ligamentous sheaths, and, in short, all such liquors of our body, do the same. From all which I would conclude, that the navel-strings which are the subject of our present inquiry, were broke very soon before birth; and if I should allow the time to have been a day or two, the foetus might continue so long in life, without any new supplies of nourishment, as well as it does several days after

(*a*) Mauriceau *Maladies des Femmes Grosses*, liv. ii. chap. 9. Ruyfch. in *Thef. Observ. adverb.*

after birth, when it ordinarily takes only some purgative syrups; and there is recorded (*a*) an instance of a child that lived seven days after birth, though nothing could pass out of its stomach into its guts to nourish it. The probability of a child's living without nourishment in the womb so long as I have allowed, is certainly much greater than that it should continue in life days, weeks, or months, after the waters have been evacuated, and continued to be constantly discharged (*b*), on the supposition which the gentlemen of the other side make of its receiving its food mostly by the mouth for some time before birth. I would therefore conclude from the whole, that these children whose histories Chatton and Rommelius relate, were under no necessity of being supplied with nourishment any other way than by the navel, and consequently do not prove what was designed by appealing to them.

A more direct proof the umbilical vessels not being so necessary as I argue for, is offered by examples of foetuses who had no navel-string. I know only two cases where this is alleged: one is told by Vander Wiel; the author of the other is anonymous.

Vander Wiel says (*c*), "In the time of the fair at the Hague, in the year 1683, a male child, a year and three months old, born of poor parents in February 1682, was exposed for a show. When it was born, there was not the least vestige of the umbilical rope; and therefore the midwife had no occasion to separate it from the child's belly. The navel also was wanting: but instead of it a broad round red spot, as large as a silver piece of money, covered with a very thin skin, appeared in the hypogastrium, near to the share-bones; within the circumference of which spot two papillulæ or aqueducts were seen, at an inch distance from each other, by which the urine was evacuated. The child died at three years of age." In the notes upon this observation he tells us, its body was not opened after its death.

This seems to me such an history as one can rely very little on: for it would appear to be on the parents information that Vander Wiel asserts there was no navel-string; their business, to be sure, was to make the case as wonderful as they could, to draw in customers. There is not any

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where

(*a*) Medical Essays, Vol. I. Art. xiv.

(*b*) Mauriceau dans plusieurs observat.

(*c*) Observ. Cent. Post. pars 1. observ. 32.

where mention of fecundines, to know whether the umbilical rope was hanging at them; and the breadth of the spot answers very well to the navel; which probably would have been made as certain by a dissection, as it was conspicuous in another case related towards the end of the notes upon this observation, and very like to it in all the principal circumstances, excepting that here the umbilical rope was evident. (See such an history in the Medical Essays, Vol. III. Art. 14.) Since then this history is so imperfect, and on an hearsay, while the very case which the author tells as analogous to it brings it to make for my side of the question, I am hopeful it will not be advanced any more against me.

The second case of a navel being wanting, is told in a letter of an anonymous author in words to this purpose (a): "An hare big with young being caught, its belly was carefully opened, and immediately three considerable balls tumbled out: they were of a whitish colour externally; with this difference, that the coat of the first which fell out was not pellucid, whereas the other two were surrounded with a pellucid coat. I considered these globes accurately, and could not observe on their surface the least mark of their adhering any where. I also with great care examined the uterus that was cut out, which I found perfectly entire, and of a natural size, without any marks of a conception, or of any breach in it. When I had cautiously cut these globes or balls, I found in each a little hare covered all over with fur, and of the bigness new-kittled hares commonly are. The membranes surrounding them were easily taken off whole and entire; but I could find no vestige of the umbilical rope either in the separated membranes or bodies of the hares. After this, I viewed the membranes more exactly, discovering them to be double and easily separable. In the ball whose membranes I said were opaque, the external one was thicker; the one within this was thin and pellucid, its internal surface being covered with a yellowish mucus. Internally, there was a space about the bigness of a guilder piece of money, that resembled a small uterine placenta, equally covered with a thin skin, but without any vestige of the umbilical rope. I cut the placentæ, and found them internally liver-like (*hepatiformes*), whitish, of a soft vascular texture, full of canals and papillulæ. These

(a) *Commerc. Literat. Norimberg.* 1731. spec. 27. art. 4.

“ These are what were partly faithfully related to me, and partly were
 “ observed and remarked by myself. Indeed, having never had an op-
 “ portunity, I did not search into the foetuses of hares before. This whole
 “ matter seems a paradox to me.”

Many inconsistencies discover themselves in this observation at first reading, even in the part of it where one would think the author is telling what he saw. Two of the balls are pellucid; and the third has only a round spot on the interior surface of its membranes, which he seems to expect should have had umbilical vessels coming out from it, and is much disappointed at missing of them. After, I say, he has thus made it evident that there were no placenta, yet afterwards hepatiform vascular placenta are very accurately described.—The membranes are taken off whole and entire from the foetuses inclosed in them, after the globes containing the foetuses had been cautiously cut.—The placenta are hepatiformes, either from their shape, form, and bulk, being before invisible; or they are like livers, because they are white.—Though it is now agreed that a placenta is no more than numerous ramifications of the umbilical vessels, yet here are placenta without their vessels being derived from any part; which to me appears to be an express contradiction and impossibility.—Though the whole affair is a paradox to him, he has not the curiosity to open one of the young hares, that he might see whether the umbilical vessels were wanting within their bodies as well as without.

Though this gentleman has concealed himself in a country where people are far from shunning to be the first public tellers of such prodigies of nature as come to their knowledge, yet I shall not doubt of his sincerity; but cannot help saying, that his ignorance, at least in the structure of the foetuses of hares, which he says he never had an opportunity of dissecting before, has led him into mistakes numerous enough to give me sufficient cause to decline his testimony. And as to the principal thing which relates to the present question, the want of a *funis umbilicalis*, I think I can, with the help of Needham's third table of his observations *de form. fæt.* make an apology for his not discovering it, by shewing that others, more accustomed to the dissection of hares, might have missed of it as well as he. Needham represents the foetus of a rabbit with its secundines, (which differ scarce any thing from those of a hare), where
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that part of the umbilical rope, in which all the vessels are inclosed, is very short, and seven or eight considerable branches go from it separately to the placenta. If these vessels were all broke at the place where they separate, by the running of the dam, or falling out of the balls, or in opening the membranes, the short navel-string would contract, and be hid by the fur, so as to be discovered with difficulty; and the extremities of the broken vessels would appear on the placenta like papillulæ, and the placenta would be vascular and whitish-coloured, as the anonymous observator has described it. This account is natural and easy enough to bear a strong air of truth with it.

If then accurate instances are recorded of fœtuses being nourished without any possibility of their receiving aliment by the mouth or into their chylopoietic organs, and if there can be no distinct unexceptionable proof made out of their being ever supplied with nourishment without the navel-string, I must determine the first problem, by affirming, That the umbilical vessels are absolutely necessary toward the nourishment of a fœtus, and that the mouth is not so.

PROBLEM II. *Whether the Liquor contained in the Amnios is proper Food for a Fœtus.*

WHEN we consider this liquor as it is sometimes represented, to wit, that it is at first mild and mucaginous, and afterwards becomes thinner, more acrid, and urinous, it would appear ill calculated for the food of the fœtus in its different states: for while the parts of a fœtus are weak, and have little action, they are not so well fitted for digesting and breaking the cohesion of a fluid whose particles separate with such difficulty; whereas it would have been much more capable of digesting stronger food after its stomach, guts, and other chylopoietic organs, were become stronger: consequently this liquor ought to have been of the reverse consistence to what is above described, as we see happens in a case which must be allowed to be very analogous to the present subject, that is, in the consistence of milk, which is at first thin and purgative, but afterwards becomes thicker and stronger food.

Needham may perhaps be said to have described this liquor really to
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be as I have argued it should have been formed; for he tells us (*a*), "That the liquor of the amnios becomes considerably thicker than it was at first in the larger animals." And in another place (*b*), he affirms, "That it gradually becomes thicker, and soon acquires the consistence of the white of an egg; nay, in the last months of a cow's going with young, it is thicker and more viscid than any gelly." This agrees exactly with what I also remarked in cows; whose foetuses, with their secundines, I have examined in a great many different ages. But neither in this view of the consistence of this liquor does it appear proper nourishment; for, according to the old adage, *Est modus in rebus*: Though the food of a foetus might be expected to be grosser in the last months, when its organs are stronger, than soon after conception; yet a liquor so very thick and viscid as Needham describes; would be altogether indissoluble, and very improper for nourishing a creature whose organs of digestion are still in a tender state, and for whom nature has provided such a dilute fine liquor as milk is, to serve for food a considerable time after the birth, when all its parts are become much more robust and strong. If we can make any judgment in this affair, from a view of the ordinary course and tenor of nature, we must think, that if the *liquor amnii* had been designed to be swallowed for food, it would have been at first a thin serum that gradually came afterwards near to the consistence and nature of milk: but this I never saw, nor do I know that any has affirmed this liquor to have been ever observed of such a proper consistence in the different times of gravitation; and therefore must conclude, that it is not designed to serve for food.

The *liquor amnii* seems not only thus improper food, while it is in a natural state; but there are examples of its being so much depraved, that it must have been of the worst consequences to the foetus to have fed upon it. Such is the history related by Dr Bellinger (*c*), of a woman who had laboured under a virulent gonorrhœa during her pregnancy, of which she was cured a very little time before her delivery. The waters were very putrid and foetid, and the membranes tender and almost rotten; yet the

(*a*) Observ. Anat. de Form. Foet. cap. 3.

(*b*) Ibid. cap. 5.

(*c*) Traët. de Foet. Nutr. cap. 9.

the child was born well and healthy; which the Doctor thinks could not have happened, if this child had received such putrid waters into its bowels.

The force of this observation is attempted to be taken off, by remarking, That poisons, and other noxious substances, do less harm when taken into the stomach, than when immediately mixed with the blood.—Every body, I believe, will grant this to be true, if the quantities received both ways are equal: but it is of no use in the present question, unless this other proposition is also proved, viz. That such a quantity of this putrid liquor, as is sufficient to nourish the foetus, must be taken in either by the mouth or umbilical vessels; then, indeed, by a plain syllogistical consequence, it follows, that such a quantity of the putrid *liquor amnii* will do less harm by being received at the mouth, than if it had been conveyed by the navel. I can, however, see no reason to allow the minor proposition to be true; nor am I sensible of being brought, by a denial of this proposition, under a necessity of giving the placenta a faculty of separating the pure from the impure, or of having the goodness to send the impure to the amnios, where it does no harm, and the pure to the foetus, where it does much good. I presume every one's practice has taught him, that there is no necessity to suppose the whole mass of the mother's blood to have been tainted by the virulent matter of this gonorrhœa. I can imagine this disease to have had its seat at first in the vagina, and then to have attacked the internal *os uteri* and the mucus with which it is commonly filled in the time of pregnancy, (see an instance of an ulcerated *os uteri* from such a cause (*a*) by Des Noves;) and this corrupted mucus might communicate its foetor to the liquor of the amnios, without the vessels of the placenta having received one drop of this putrid liquor: And therefore, according to the doctrine which I endeavour to support, the child might remain healthy and sound, unless the waters had been long enough acrid to affect the surface of its body; whereas, had such putrid liquor served it for food a very short time, it scarce could have escaped without some disease. Nay, from what was said concerning the source of the *liquor amnii* being either the foetus, or its umbilical arteries, (*vid.* § 24. and 26.), it necessarily follows, that the *liquor amnii* in this case could not have been corrupted in any other way than what I have

(*a*) Morgagn. *Advers. Anat.* 4. animad. 40.

have just now assigned ; for we can never imagine that a child could have such corrupted liquors circulating in its vessels without being tainted.

It may be objected, from what I have said (§ 25.) of the branches of the umbilical vein absorbing the *liquor amnii*, that supposing this liquor to have been corrupted in the manner I have explained it, the foetus could not have remained sound ; because the absorbent veins must have taken up this corrupted stuff, to mix it with the blood of the foetus. To this I answer, That the quantity taken up by absorption is but small, and the time would appear to have been but short in which it could here have been absorbed. Next, I would observe, That though a gentle contraction is necessary for increasing absorption, yet very acrid substances irritate absorbent vessels to such a strong contraction, as makes them incapable of performing their functions, which I take to be one principal reason why poisons, when swallowed, do so much less harm than when they are immediately mixed with the blood : And hence the very acrid kinds of them are observed to produce all their bad effects on the *primæ viæ*, without any appearance of their having entered the blood-vessels (a). So that we have reason to think the child to have been in much less danger of suffering, by what the absorbents of the amnios could take up in such a case, than if the putrid liquor had been swallowed for food, when it would surely have hurt the alimentary tube ; and if it had gone further, it must have tainted the whole mass of blood ; or if the lacteals had refused it entrance, the child would have been famished ; and, at any rate, it would have laboured under some disease ; whereas, in the history, it is affirmed to be have been sound and healthy.

Whether, then, we consider the liquor of the amnios in a sound or morbid state, it appears to be very ill calculated for serving as food to be taken into the stomach of a foetus.

PROBLEM III. *Whether the Liquor Amnii passes into the Stomach of a Foetus.*

THE impossibility of having ocular demonstration of the fact inquired after in this third problem, has occasioned a great many circumstances to be used by way of arguments, each of which we must examine ; and if

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(a) Wepfer de Cicut. Aquat. Mead on Poisons.

they all point one way, and the conclusions arising from them are favoured by the solutions of the two preceding problems, the general conclusion concerning the nutrition of the foetus will be sufficiently warranted.

The first thing I offer against the *liquor amnii* passing into the stomach of a foetus, is the improbability of a liquor that is to serve for food, being previously sent into the foetus's own vessels, there to circulate and to be secreted, in order to prepare it for being swallowed, which § 24. and 26. show would be the case on this supposition.

No matter, where this liquor is separated, or from what source it comes, will the advocates of the other side say, if its passage into the stomach can be proved; which they infer does happen, from,

1. The resemblance which they allege is to be seen between the liquor of the amnios and that of the stomach.

I have already described the liquor of the stomach, as I have seen it in foetuses of different animals, (see § 30.); but have not had opportunities to observe the liquor of the amnios in the different states of a sufficient variety of foetuses, and therefore shall first consider it as it is represented by the gentlemen who differ in opinion from me, and afterwards shall suppose what I saw in cows to be general.

If the liquor of the amnios is at first mild and mucaginous, and afterwards becomes thinner and more acrid, it differs greatly from the liquor of the stomach, which, on the contrary, turns gradually more viscous as the foetus increases, (§ 30.) Nor will it suffice to say, that the finer parts are absorbed by the vessels of the stomach: for, by such an absorption, it could never happen, that a thin watery liquor would leave a greater quantity of gross mucus than a thick gelly would do; especially when there is less time allowed for the absorption of the watery liquor, by the quicker digestion which the foetus must be supposed to have when it becomes larger and stronger. Upon which account, too, the contents of the stomach would be more and much oftener diluted by the thin food swallowed in greater quantities, and more frequently. And then we might expect sometimes to see the thin liquor lately taken down, and the thick remains of the former food, distinct, without being blended; as we observe the mucus of the stomach of adults to keep in a separate body from any thin liquors drunk some little time before they are vomited. This, however, is
never

never observed in the foetus, though it has neither respiration, vomiting, nor other conquassatory pressure on its stomach, to incorporate the different liquors contained there; and therefore there is no probability that they should be so intimately blended. So that, on the whole, the liquors of the amnios and stomach are so far from resembling each other in this case, that their appearances discover them to be very different, and destroy the supposition of that of the amnios ever being sent down into the stomach.

Let us next see how well the *liquor amnii* of cows, taken for a general rule, will serve to support this alleged resemblance. It must indeed be owned, that, till the liquor of the amnios comes to a certain degree of viscosity, which, as near as I could guess, happens when the cow has gone three-fourths of her time, the appearances of resemblance are pretty favourable: only, while the foetus is very young, the objections to the former supposition take place; because, for some time, this liquor is glairy, then becomes more watery, and afterwards thickens, till it comes to much the same consistence with that in the stomach, at the period just now mentioned; after which the appearances are quite destructive of any resemblance, for the *liquor amnii* becomes considerably thicker. And even during that favourable period, when their consistence is so like, I have often seen the *liquor amnii* of a dark brown-colour, and turbid; while the liquor in the stomach was of a very pale watery colour, and pellucid: And at other times I have observed the contrary of this, and other remarkable varieties of appearance; which persuades me, that there is no communication between the cavity of the amnios and the stomach.

It will be remarked, that I have made no comparison of the taste, smell, or coagulation of these two liquors; which is omitted designedly, because neither smell nor taste are very greatly different in any of the saltish watery liquors of the body: for that in the pericardium, thorax, abdomen, joints, the saliva, &c. of a foetus, smell and taste as like to either of the liquors that are the immediate subject of our inquiry, as these two do to each other; and different salts, heats, &c. produce much the same effect upon all of them.

2. The liquor of the amnios is said to be generally consumed, or in very little quantity, at or near the birth; from which it is inferred, that it has been swallowed down by the foetus. De Graaf, in confirmation of

this fact, tells us (a), that he dissected a rabbit when she was about to kittle: In the time of his dissecting the mother, some of the foetuses came out with their membranes entire, and without any liquor contained in the amnios or chorion. He observed also the same thing in the others that were taken out of the uterus; and, to be assured that the coats were not broken, he distended the membranes with air, and found they were entire.

Whatever truth is in the general proposition, I think De Graaf's observation, which he fancies equal to a proof of it, is good for little; because it shows only what happened in that particular animal, without determining what the quantity of the liquor is for ordinary in rabbits; far less does it teach us what we ought to say of animals in general.

I am certain that a great many creatures have not all this liquor consumed at birth, having had my arm wet up to the shoulder when the waters broke, while my hand was in the vagina, in some cases where necessity has obliged me to act the accoucheur to women; and we see every day how the cloaths are wet when the waters come away. I have also seen a remarkable quantity of liquor still remaining in the amnios after the delivery of several animals; but my observations have not been sufficient to determine (except in one species of animals, cows,) what proportion the liquor of the amnios bears at birth to what it was formerly; and I know no author, except Harvey, who seems to write on this subject accurately and from observation. When he is endeavouring to prove the *liquor amnii* to serve for food to the foetus, he raises this objection to himself (b): "One might believe, that the liquors which we appointed for food to the foetus are excrementitious; and chiefly on this account, because they increase as the foetus turns bigger; and in the birth of several creatures, when it is probable all the aliment is consumed, they are seen in great plenty." And where he is treating of the human waters, and is proving the *liquor amnii* to be no excrement, he says (c), "It is seen in less quantity proportionally (*pro proportione*) near the time of birth." Allow me to add, what observations frequently repeated have taught me, that in cows this liquor is evidently decreasing in its quantity some months before the delivery.

It is evident what a loss I must be at to lay down any general rule concerning

(a) De Mulier. Organ. cap. 15.

(b) De Humor. Uteri.

(c) Exercit 56.

cerning the proportional quantity of the *liquor amnii* in the different times of gravitation in different animals. What the gentlemen who differ in opinion from me will undoubtedly be best pleased with, is to take my own observations on cows as the general rule; which I am satisfied rather to do, than to be exposed to perpetual wrangling about this fact. Let us suppose then, that the liquor of the amnios increases in its quantity for some more than the first half of the time of gestation, and after that decreases, till at the birth it is in very small quantity. The consequence they draw is, that the consumption of the liquor is made by its passing into the stomach of the foetus. But, with submission, they cannot come so soon at their conclusion: They must previously prove one or other of these two propositions, either that the liquor does go down into the stomach, or that it cannot possibly be carried off any other way. The truth or falsehood of the first of these depends on the arguments examined in the subsequent part of this essay, and must share the same fate with them; and, as to the latter proposition, I flatter myself that I have demonstrated another passage by which it may go (§ 25.), and really by which only we can suppose it to go, in order to account for all the phenomena, which I would do thus. While the foetus is weak, the arteries of the amnios pour out more than the veins take up, (§ 15. and 26.); and the heat, assisted by the conquassatory motion to which the liquor is exposed, melts down its particles, and makes it appear more watery: But, when the vessels of the foetus become stronger, and consequently the veins absorb more, (§ 15.); the quantity collected does not increase so fast, and in some time liquors thrown out and those absorbed are pretty near equal, when the quantity of the *liquor amnii* remains much the same; till at last, the veins prevailing, the quantity diminishes, and continues to do so till birth. But, seeing the veins take up chiefly the finer particles, what they leave must become more thick and viscous. All this will, *cæteris paribus*, be observed in different animals proportionally to the sizes and numbers of the vessels. If what Rohault (a) affirms be true, of the human *liquor amnii* being always in a watery state, (which, so far as I could observe, it is rather more than in other creatures,) the arteries or exhalant vessels are smaller, and the veins perform less absorption than those of brutes do.

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(a) Mém. de l'Acad. des Sciences, 1714.

This *liquor amnii* serves to keep the foetus and its membranes soft and extensible; hinders them from cohering; and defends the foetus from pressure or other violence, which it needs most to be protected from while its parts are very tender, for which this liquor is then, at least, in greater proportion than afterwards when the foetus is firm and stronger; and, by the liquor's real or proportional quantity being less towards the time of birth, the mother is not in so much danger of suffering by the overstretching of her uterus, as she certainly would be if the waters increased proportionally with the foetus.

What I have said of the changes produced on the *liquor amnii*, will perhaps be better understood, by naming some analogous cases: such are, the viscid nature which the water in a dropsy of old standing acquires; the progress of encysted tumors from a hydatid to a steatom; the course of a large oedema at the end of an acute disease, to its changing into what the surgeons call a *white swelling*; and at last to its cure. None that I know ever affirmed the liquors re-assumed into the mass of blood in any of these cases; nor what is constantly absorbed in a natural state, from the pericardium, thorax, abdomen, &c. to serve as nourishment; and therefore I cannot expect, that what is just now said of the *liquor amnii* will weaken what I said formerly of the improbability of a creature's furnishing its own food.

3. Besides these arguments deduced from the quality and quantity of the *liquor amnii*, it is further pleaded by those who favour the opinion of the nutrition of a foetus by the mouth, that the foetus shews it was in use to take down aliment while it was in the womb, by its knowing how to suck as soon as it is born.

This is building on that *divinae particulae auræ*, that principle which is commonly called *instinct*, and of which we observe daily examples in propagating the species, and preserving the individuals among animals, but of which we have no comprehension. Can any one assign a physical cause, why of ducklings and chickens hatched under the same hen, the former should, contrary to the example and anxious warnings of the parent, run into each pool they can come at, while the others shun going into water? Who taught a young stallion that has been always kept out of sight of mares, either the instruments or manner of generation. And,

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in the present case, what is there in the least analogous to a nipple within the amnios, on which the foetus could have practised sucking while in the womb? These are subjects we may admire, but lose ourselves whenever we pretend to account for them.

4. Here is, say they again, a liquor in the amnios constantly applied to the orifice of a canal that leads to a cavity, and therefore it probably will pass down there.

To this it is answered, That there are impediments both to the entry and passage of the liquor.—The first is, the lips being generally found shut in a foetus. This, however, is denied by the other side to be true in fact. In my opinion, it is of no great consequence in the argument, whether the lips of a foetus are found to be contiguous or not, unless some other circumstances can be determined at the same time. If the lips, for example, are found shut, it is necessary to know whether the foetus, while in life, had not, or did not exercise, the power of opening them: And if, on the other hand, the mouth is seen open, we ought to inquire whether that is not owing to the shrivelling contraction or handling of the parts after death. In most of the foetuses of cows which I looked at, the lips were contiguous; in some few, I have seen the point of the tongue lying between them; and, in all the human foetuses which I have had the opportunity of seeing, the lips were contiguous. One might indeed judge that the mouth generally would be shut in a living foetus, from what was said (§ 29.) of the muscles of a foetus being left to their natural action, and from what we see in most animals when they are asleep. The force by which the lips are kept contiguous, will, however, not probably be so great as that by which the eye-lids are shut, because the *sphincter oris* does not seem to be so much superior to its antagonists, as the *orbicularis palpebrarum* is to the *rectus aperiens palpebram*.

This obstacle of the lips is not the only one: for the under-jaw, being supported by its levators, will keep the tongue applied to the roof of the mouth; and the pharynx always is shut in animals, unless when the voluntary convulsive action of deglutition is performed. That I might know how these parts appeared in a foetus, I opened the mouths of several; then cautiously depressing the point of the tongue, I saw the root of it raised up against the palate. When the root was also depressed, I observed
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the *velum pendulum* was hollow below, where the tongue had been lodged ; and was so convex above, as to shut up the passages to the nostrils. As to the pharynx being always shut, it is universally known : but, to make sure of it, I put a funnel into the mouths of several fœtuses, after their tongues were depressed ; and, holding them erect, I poured water into the funnel, but none passed farther than the root of the tongue.

I cannot omit the mention of the remarkable mechanism employed here, for keeping the tongue closely applied to the palate ; choosing the human fœtus, as best known, to illustrate it by. It is known, that the force exerted by muscles in their natural contraction is increased and diminished proportionally to their being more or less stretched. It is also known, that the muscles coming from the jaw to the tongue and *os hyoides* are thicker, consequently stronger, than those that come to these parts from the sternum and scapulæ. Now, when a fœtus lies with its neck bended, such of those muscles as are situated below the *os hyoides* are considerably relaxed, which those above it are not. Since therefore these latter are naturally stronger, and gain so much over the others by the difference of their stretching, it is no wonder that they pull the *os hyoides*, tongue, &c. strongly upwards, and press them so strongly against the upper part of the fauces and mouth, as to leave their print in the flexible parts, and, by bringing all the sides of the passage into the œsophagus close together, prevent any thing from getting down into it.

Since then there are such obstacles to be overcome, the *liquor amnii* cannot pass, unless either the force with which it is squeezed is superior to the resistance, or the fœtus must perform the action of deglutition.

I shall not stop here to consider the bad consequences which such pressure on the very tender parts would have, while the chasm of the mouth is not shut (§ 28.) to make resistance ; but shall proceed directly to examine what is called by several writers an experiment which demonstrates the passage of the liquor of the amnios into the stomach. It is related thus by Mr Heister (a) : “ I received a full-formed perfect fœtus of a cow, “ inclosed in the uterus and membranes, in cold winter weather, where “ not only the liquor of the amnios which surrounds the fœtus was “ frozen, but the same liquor was found frozen in the mouth, œsopha-
“ gus,

“gus, and stomach, like one continued substance: The column of ice
“in the œsophagus was about an inch thick. I happened to see the same
“another winter.”

If any use is to be made of this experiment, in proving the *liquor amnii* to be sent into the stomach, it must be said, that the freezing of the liquors did no more than show more distinctly how the waters were lodged before they were turned into ice: and if this is true, then we would see all the contents of the stomach run out, whenever a foetus is suspended with its head lowest; or, if the mouth and œsophagus are slit open, while the foetus is hanging by its mouth after being taken out of the *liquor amnii*, we would observe part of the column of water to run out at every cut, and all the canal would be seen full below where it is opened. These things would certainly, I say, be seen, if the experiment did no more than consolidate the water naturally lodged in the œsophagus. But, after many repeated trials, I can declare, that none of these things do happen; and therefore it is more reasonable to believe, that the icy column which Mr Heister saw in the œsophagus, was introduced there from the amnios or stomach by the immense expanding force of freezing liquors confined within the frozen rigid uterus and secundines, which every body knows is far superior to any resistance can be supposed here.

To make myself still more certain about the nature of this experiment, I repeated the trial already mentioned, of pouring water into the mouth through a funnel; and, that it might not be thought to be hindered by the liquors already contained there, I emptied the stomach before I began to pour the water; but still the same success of nothing passing down attended it. To confirm all more, I pushed a trocar into the amnios of several calves involved each in its uterus and secundines, and forcibly injected milk through the canula of the trocar; then I caused the uterus to be pressed strongly by several people, sometimes equally, other whiles alternately: but though the milk was thus intimately blended with the *liquor amnii*, none of it would pass into the stomach; which to me is a demonstration, that Mr Heister's experiment ought not to be mentioned as a proof of what naturally happens to a foetus, but only as a trial of the force of expansion in freezing liquors.

It is hardly worth while to take notice of those who say, that the pressure

ture which the *liquor amnii* suffers must make it go down through the open mouth into the vacuum formed in the stomach: For the mouths of foetuses are oftener found shut than open; there never can be a vacuum in the stomach; and the external pressure must be equal on the stomach as on the mouth.

5. The only other supposition to be made of the foetus taking the *liquor amnii* into its stomach, is, that it swallows down these waters, by performing the voluntary convulsive action of deglutition.

The gentlemen who assert that the foetus does perform deglutition, say, that because it has the organs of deglutition, and a capacity of exercising them, therefore it performs this action as well as it employs some other muscles in its stirrings. But this way of reasoning can never serve their purpose; because there are many other actions which a foetus has the organs and capacity to perform, and yet evidently does them not. They must therefore previously shew some necessity the foetus is under to perform this particular action, or some manifest advantage it is to gain by it. There can be no such necessity; and I hope it appears, by what was said in the solution of the second problem, and elsewhere in this paper, that the taking the *liquor amnii* as food, the only advantage to be imagined here, would be hurtful to them: And therefore, if the will did contribute to the actions of these organs of deglutition in a foetus, it would be directed by instinct to keep the passage into the stomach close shut, instead of forcing down the *liquor amnii* into it.

That sometimes foetuses swallow the contents of the amnios, is evident, say some, from the *fæces alvinæ* having been seen both in the amnios and stomach of foetuses (a). And, add they, if a foetus does sometimes swallow, it probably does so always.—To which it may be answered, 1st, That in a few extraordinary cases here referred to, it is not certain that the *fæces* were swallowed; for since genuine meconium is to be seen in the jejunum and ilium of foetuses (b), and new-born children have vomited meconium (c), why might not the *fæces* found in the amnios in the morbid examples cited have been brought up from the stomach? Needham, one of the authors quoted, gives a very reasonable objection to the *fæces*.

(a) Needham de Form. Fœt. cap. 5. Steno in act. Hafn. tom. ii. obs. 89.

(b) Haller, not. f. in Boerhaave Instit. § 583.

(c) Mauriceau, Obs. 300.

fæces being swallowed, if even they were evacuated at the anus of a fœtus: For, says he, "The thickness or viscosity of the *liquor amnii* is so great, that it does not easily mix with them; neither can what is voided " by the anus be allowed to come to the mouth of the fœtus."——2dly, Though it were granted, that in the above cases the fæces had been swallowed, the conclusion that the contents of the amnios are ordinarily swallowed, has been too hastily made. They might as well infer from these cases, that the *fæces alvinæ* are for ordinary to be found in the cavity of the amnios, which every body knows to be false. We may endeavour to account as well as we can for these morbid phænomena; but we must not draw such hasty general conclusions from them.

Slade (a) observed, among the glutinous fæces contained in the rectum of a fœtus calf, hairs of the same colour with those which covered the calf; from which it is inferred, that the calf must have swallowed these hairs.—Whoever makes this inference, must likewise say, that the calf had licked itself with its tongue a considerable time before, and with it brought off these hairs which were found in the rectum: for hairs do not fall off from fœtuses for ordinary; and Slade takes no notice of hairs in the liquor of the amnios or the stomach, though he describes both, and in such a manner as to show, that the calf did not swallow the liquor of the amnios, for that of the stomach was more viscid and whiter-coloured than it. Why might not these hairs have been formed in the guts of this calf, as they are formed frequently in the omentum, urinary organs, heart, arteries, intestines, &c.?

6. Left the direct proof of the *liquor amnii* being pressed or swallowed down should fail, there are some other arguments advanced that are thought to imply a necessity of such a liquor having been taken down: among the rest, it is argued, That it is necessary to keep the chylopoietic organs of sufficient dimensions, for receiving the due supplies of food after birth.

If it had been considered how very languid and slow the motion of the contents of these organs must be in a fœtus, where the contractile tone of its own fibres is so very weak, and where there is no exterior alternate pressure by respiration or any other power, it might have been thought,

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that

(a) Apud. Blaf. Anat. Animal. p. m. 122.

that the liquors supplied by the vessels of these hollow viscera would be sufficient for this purpose, without the addition of any thing from without; and what we observe of the youngest foetuses we can dissect, having their stomachs full (§ 30), seems plainly to point out the source of the liquors there to be no other than the bowel itself. It would appear to me, that the contrivance of pushing the blood in the descending aorta, with the united force of both ventricles of the heart (§ 10.), is in part designed to promote a greater secretion in these hollow viscera, where the resistance to the effusion of the liquors will be less than in ordinary glands.

7. The quantity of mucus in the stomach and small guts, and of the meconium in the great guts (§ 30. 31.), is looked upon by several writers as a very convincing argument for the foetus's feeding on the liquor of the amnios; and, as a proof *à posteriori*, they mention De Graaf's (a) example of a whelp brought forth without a head, whose stomach was empty, and in whose intestines there was found but a small (*modica*) quantity of excrements. It is also probable, that a circumstance in the second child which Mr Calder describes (b) may be made use of here, viz. That having the passage from the stomach into its guts shut up, there was but a small quantity of meconium in its great guts. For it may be said, that De Graaf's whelp shews the stomach not to furnish its own liquor, but to receive it from the mouth, and, as well as Mr Calder's child, had little meconium, because the *liquor amnii* was not sent down into the guts.

I am so far from thinking that the quantity of matter ordinarily contained in the stomach and guts of a foetus, is any argument for food being furnished from the amnios, that, on the contrary, it appears to me very strong against that opinion: for it is not to be imagined that the meconium should be thecrement of any proportion worth notice of the food it had during the whole nine months of gravitation, seeing there is scarce more meconium than what an infant, when it is nourished by the mouth after birth, passes of faeces in one day; and that the colour of the meconium evidently discovers the liquors secreted within the the foetus's body to compose the greatest share of it.

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(a) De Mulier. Organ. cap. 15.

(b) Medical Essays, vol. i. art. 14.

If De Graaf's whelp is applied to the use I have made of it, namely, to prove the stomach incapable of furnishing any liquor, because this one was found empty, it will certainly be allowed by every one to prove too much; since none can, with any sort of reason, say, that the stomach secerns no liquor. But lest I should be said to extend this example designedly to too general a conclusion, in order to elude the natural consequence, I shall give my opinion of the fact as it is related. It is this, That I would blame a faulty disposition in the vessels of that whelp's stomach for its emptiness; because I shall soon give positive proof of the stomach's being capable of furnishing the quantity of liquor commonly found there in foetuses, without receiving any thing from the amnios.

It needs be no surprize that there were few excrements in Mr Calder's child, since the two great sources of them were wholly or in part stopped. The stomach sent nothing down; and the divided duodenum hindered the biliary and pancreatic liquors to pass freely.

But, to overbalance these two examples, and indeed the general argument also, by positive proof of the stomach and guts being able to furnish their contents, which must be of more weight than any negatives can, I shall likewise mention two histories. The first is of the pig, which Dr Bellenger (*a*) describes, brought forth with its mouth quite shut up, but having its stomach and guts full of the usual contents. The other instance is rather stronger: for Mr Antoine (*b*) found a glairy yellow liquor, like to excrements, in the stomach and guts of a lamb, that had neither head, heart, lungs, liver, nor pancreas; which I hope will be convincing, that the meconium is no other than the grosser parts of the liquor secreted in the alimentary tube, and of the bile and pancreatic juice.

These are all the arguments of any weight that I know to be advanced for proving the passage of the *liquor amnii* into the stomach. In answer to which, I have offered reasons, which seem to me to turn them all in favour of the side of the question opposite to that for which they were advanced; and therefore I must conclude this third problem, by asserting, "That the *liquor amnii* does not pass into the stomach of a foetus."

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(*a*) De Fœt. Nutr. cap. 9.

(*b*) Hist. de l'Acad. des Sciences, 1703.

The CONCLUSION.

SEEING, then, all the three problems are resolved, with respect to viviparous animals, so as to favour the nutrition by the navel alone, allow me to sum up all by a short recapitulation of the arguments which I have insisted on at so much length.

The foetus being capable of receiving its whole nourishment by the umbilical vein alone, whereas none can subsist without the umbilical vessels.—The liquor of the amnios being ill calculated in its natural state for the food of a foetus; and becoming sometimes altogether unfit food in morbid cases without the foetus being any way injured.—It being highly improbable that a creature should furnish its food out of its own body, which must be the case if the foetus feeds on the *liquor amnii*.—Seeing it cannot be inferred from any resemblance of the liquors of the stomach and amnios, nor from any other appearances, that that of the amnios ever is sent down into the stomach.—Seeing no direct proof can be had of the *liquor amnii* being pressed or swallowed down; but, on the contrary, all circumstances make it probable that it does not go down.—And since all the phenomena of a foetus can most reasonably be accounted for, without supposing the liquor of the amnios to be any part of its food; is it not reasonable, after all this, to exclude the mouth from the office of conveying the aliment of the foetuses of viviparous animals, and to believe that all their nourishment is conveyed by the umbilical vessels?

SECTION II.

I COME now to consider, “How far the nutrition of the foetuses of oviparous animals, and of plants, serves to illustrate or confirm what has been argued for in the preceding section;” the plan of which I shall here follow: but beg to be excused, if, instead of mentioning only the facts immediately necessary, I take the liberty to give a short history of an egg, and of the changes brought on it by incubation, with an abstract of the formation and vegetation of the seeds of plants. My reasons for taking in more facts than are just necessary, are, That several of these cannot be
rightly

rightly understood, without a previous knowledge of others : and, in the next place, I have observed, that such an history of eggs and plants as I propose to give here, is very little known, notwithstanding accurate treatises have been wrote on these subjects ; which I think may be attributed to their being treated of in a manner that requires more study than most people are willing to employ, in picking out, from among the numerous particular examples these authors describe, the facts necessary for composing an ordinary general system ; which is what I aim at here.

Of the Nutrition of the Foetuses of Oviparous Animals.

To save the perpetual repetition of my being assured of the truth of each fact by repeated observations, I have to observe once for all, that unless where I expressly confess I had no opportunity, or neglected to examine them, I consider myself obliged to give ocular demonstration of what I assert.

1. The shell of an egg becomes more brittle by being exposed to a dry heat.

2. The shell is lined every where with a very thin, but pretty tough membrane ; which, dividing at or very near to the obtuse end of the egg, forms a small bag, where only air is contained.

3. In a new-laid egg, this folliculus appears very little, but becomes larger when the egg is kept.

4. The albumen, or white of an egg, is contained in concentrical membranes, but is not all of the same consistence : for the exterior part of it is thin, and diffuses itself almost like water when the membranes are broke ; whereas its interior part is more viscous.

5. The white of an egg can make its way through the shell, as appears from its wasting by keeping, especially if it is exposed to gentle heat.

6. The globular vitellus or yolk would seem to be no other than a liquor inclosed in a membrane ; because, whenever the membrane is broke, it runs all out ; and it is specifically heavier than the white.

7. The chalazæ are two white spongy bodies, rising very small from opposite sides of the membrane of the yolk, but gradually become larger

as they are stretched out from it in an oblique direction with regard to the two ends of the egg.

8. If we compare the chalazæ to the extremities of an axis passing through the spherical vitellus, this sphere will be composed of two unequal portions, its axis not passing through its centre; consequently, since it is heavier than the white (§ 6.), its smaller portion must always be uppermost in all positions of the egg.

9. The yellowish-white round spot, called *cicatricula*, is placed on the middle of the smaller portion of the yolk; and therefore, by § 8. must always appear on the superior part of the vitellus.

10. The *cicatricula* seems to be composed of several circles of different colours; and, in a fecundated egg, contains the embryo or chick. See Malpighi ().

11. Eggs, whose obtuse ends are all rubbed over with lintseed oil, or such other substances as block up small pores, are as fit for bringing forth chickens, when incubated by a hen, as other eggs are.

I did not make the experiment; but can give a voucher, whose scrupulous candor, with sincere good wishes and endeavours for the improvement of physic in this place numbers must be acquainted with: I mean my father; who besmeared eighteen eggs in the manner mentioned; then having put a mark on them, he set them, with the like number of other eggs, under three hens, who brought out thirty-six chickens, not one egg of the whole number failing.

12. After INCUBATION, the *folliculus æris* is gradually extended; till, near the time of the exclusion of the chick, it occupies, as near as I could judge, some more than a third of the cavity of the shell.

13. The extended folliculus does not collapse, upon being exposed to the pressure of the atmosphere, after incubated eggs are opened (*b*).

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(*a*) De Ovo Incubat.

(*b*) It is somewhat out of my sphere to inquire how this additional air gets into the folliculus: but if any are curious enough to make this inquiry, I would recommend to them to observe how this folliculus distends and keeps stretched in an exhausted receiver of an air-pump; to exhaust the air gradually out of the shell, while it stands exposed to the atmosphere, both while the folliculus is entire, and after it is broke, observing always the rising or falling of the mercurial gage; to consider § 11. and 13.; and to consult Bellini *de mot. cord.* prop. ix. and Hale's Staticks.

14. By incubation, the albumen becomes thinner and more turbid, especially on its upper part near to the air-bag, where it is also first consumed: and it is afterwards diminished towards the sharp end of the egg, till at last nothing of it is left except a white cretaceous substance at the lower part of the shell.

15. As the part of the white nearest to the cicatrix is wasted, its membrane and the cicatrix still approach nearer till they become contiguous. This membrane of the albumen is what is commonly called the *chorion*.

16. Some time before the albumen is quite consumed, what remains of it is placed at the lower part of the egg; and therefore the yolk is interposed betwixt it and the membrane which immediately contains the foetus. See § 9. and 10.

17. The white of a fecundated egg is as sweet and free from corruption, during all the time of incubation, as it is in a new-laid egg.

I tasted, smelled, and swallowed the whites of eggs during all the states of incubation, both when they were raw and boiled, and constantly found it as just now described; and therefore cannot imagine how Bellini (*a*) could affirm it to have a heavy, abominably-ungrateful taste, a stinking smell, and not only to occasion, when swallowed, a troublesome sensation in the stomach and guts, but to prove purgative. He must unfortunately have examined none but subventaneous eggs: which is further confirmed by his description of the small particles in the colligated albumen, that reflect light so strongly as the eye cannot bear it; which I saw in some subventaneous eggs, but could not observe in any that were impregnated.

18. According to Bellini (*b*), the colligated white always becomes incapable of coagulation by heat; but in the trials I made, it frequently did coagulate, though I found the success of this experiment very uncertain: the only general rule I could fix was, that, before the 9th or 10th day of incubation, the thinner white did not generally coagulate; but after that it frequently did.

13. Very soon after incubation, the volume of the yolk appears increased;

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(*a*) De Motu Cord. p. op. vi.

(*b*) Ibid.

fed ; and, by its rising then nearer to the upper part of the egg, one may conclude, that its specific weight decreases.

20. The yolk becomes pale and more fluid for some time, especially on the side next to the chick, where its bulk also soonest increases ; but afterwards the membranes of the yolk turn firmer and stronger, and the liquor in them is less in quantity, and becomes more viscous.

21. As the chick increases, the yolk is depressed in the middle ; and is soon brought into a form something like to a horse-shoe, in the middle of which the chick is lodged.

22. The yolk remains fresh and uncorrupted all the time of incubation, and is always coagulable.

23. Not long before the exclusion of the chick, the whole yolk is taken into its abdomen.

24. The whole albumen and vitellus are not consumed by the chick : for some part of the humours of the egg escapes through the shell, and is not supplied by any thing from without ; as evidently appears by an egg's becoming so much specifically lighter, as to swim in water after incubation, though it sunk in it when recent.

25. The chalazæ remain long without being considerably changed, unless that they are brought nearer to each other by the crescent form of the yolk ; at last they degenerate into a dry chalky substance.

26. The cicatrix very soon is enlarged by incubation ; and, being buoyed up on the top of the yolk to the superior part of the egg, it is placed very near to the air-bag ; and when both increase, they become contiguous.

27. The cicatrix is called *amnios*, when it becomes large, and contains the colliquamentum or liquor in which the chick is immersed.

28. The quantity of the colliquamentum gradually increases till the 15th or 16th day of incubation ; on the 18th, it is all consumed ; and, in the three following days, scarce any moisture can be observed on the internal surface of the amnios.

29. The liquor of the amnios is more clear and transparent than the colliquated white ; its taste is more salt, and it has no observable smell. Its consistence is at first a little viscous, then it becomes more fluid, and afterwards turns a little ropy again.

N. I can say nothing of the particular times when it does or does not coagulate by heat: for it is in so small quantity, during the greater part of the time of incubation, that one can scarce gather as much in a spoon as is fit to make any experiment with; and when all the egg is boiled hard, it adheres so closely to the white, that it is scarce possible to distinguish one from the other. Malpighius (*a*), speaking of the egg between the 14th and 19th day, says, "That this thin diaphanous liquor of the "amnios was sometimes forced by boiling into a white tasty substance;" which my trials also confirmed.

30. The allantois and its contained urine are to be seen in an egg, as well as in the secundines of viviparous animals (*b*).

31. Though the heart is among the first parts of the chick that can be distinguished, yet the umbilical vessels are seen much about the same time that the heart is observed.

I did not inquire into this fact; but have two very good vouchers for its truth, Harvey (*c*) and Malpighius (*d*).

32. The umbilical vessels gradually disperse their branches upon the amnios, upon the vitellus, and upon the membranes of the albumen: The extremities of their much greater number, being immersed into the white, are extended proportionally as it is colliquated.

33. Near to the end of incubation, the umbilical vessels begin to shrivel and decrease, till at the exclusion they are very small.

34. The embryo is seen in an egg at first in form of a small worm: then its carina or spine, with the large prominencies that afterwards shew themselves to be the brains and eyes, appear; the other bowels seem hanging from the spine; the chasm of the mouth discovers itself; the extremities sprout out; the viscera are gradually covered with the teguments; and at least the beak, nails, and feathers are seen: after which, all the parts become stronger and firmer, the proportional bulk of the head decreasing.

For the particular times when all these changes are thus orderly brought about, consult Fabric. ad Aquapendente, Harvey, and Malpighius.

35. After all the parts of the chick are formed, it is always found lying

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(*a*) De Ovo Incubato.

(*b*) Malpig. Append. de Ovo Incub. tab. vii.

(*c*) De Generat. Animal. exercit. 16. & 17.

(*d*) De Ovo Incubato.

on its side, with its neck greatly bended forward, the head being covered with the upper wing, and the beak placed between the thighs.

36. When the shell is opened after the chick is large and strong, it may be seen to bounce and spurn, sometimes opening its mouth wide, especially if it is stirred or pricked.

37. The mouth, œsophagus, and ingluvies, are always found moist; but never contain any quantity of liquor that can be collected or will run out in drops.

38. The bulbous glandular part of the œsophagus immediately above the stomach, or what Peyer (*a*) calls the *infundibulum*, and the stomach, are full of a liquor, in the youngest chick we can dissect, and continue full the whole time of incubation; neither *infundibulum* nor stomach having yet got the tendinous firmness they have in adults; nor can we observe the dry pellicle which is so easily separated from these parts in hens.

39. This liquor of the stomach is at first thin and more watery; afterwards it becomes curdy; and at last is all in form of a greyish white mucus, unless that some part of it frequently is coloured yellow or green by a mixture of bile. It always coagulates, by boiling, into a firm yellowish white substance.

40. The quantity of fæces was not large in the great guts, of any chickens I opened before exclusion.

41. A little time before the exclusion, the chick may frequently be heard making the same pieping sound that hatched chickens make. In three eggs, which were all I opened in this state, the beak of the chick had perforated the membrane of the *folliculis æëris*.

42. The shell at the obtuse end of the egg frequently appears cracked some time before the exclusion of the chick.

43. The chick is sometimes observed to perforate the shell with its beak; but, in those I saw tumbling out of the shell, it was broke off irregularly, at the place where the membrane of the *folliculis æëris* was joined to it.

44. After the exclusion of the yolk is gradually wasted, being conveyed into the small guts by a small duct, its membranes gradually contract them-

(*a*) Comment. in Anat. Ventricul. Gallin.

themselves, and the duct becomes shorter. On the tenth day after exclusion, the vitellus was no larger than a small pin-head, and the duct was scarce one twentieth part of an inch long.

From this history of the egg and of incubation, I shall endeavour to deduce the manner in which the colliquated white is taken in by the chick.

Authors generally seem to agree, that the oviparous foetus, while very young, receives its nourishment by the navel; but several of the best reputation have been of opinion, that afterwards it is conveyed by the mouth. I shall examine the arguments they used in proof of this, and then shall subjoin some negative reasons which they have not taken notice of.

Bellini (a) has described the cicatricula, or *sacculus amnii*, with the chalazæ first formed in the back of the hen; to which, according to him, the vitellus is afterwards joined, and the white is acquired as they tumble down the oviduct. He says the chalazæ are composed of numerous canals, which open into the amnios, and send out their roots into the cavity of the yolk, and into the white. It is easy to conceive what consequences may be drawn from this description, by those who assert the nourishment to be carried by the mouth, viz. That here are direct passages into the cavity where the chick is, which can take up the liquors no other way than by the mouth.

The answer to this observation is the same as has been made to the other facts already quoted from this author. I deny that the *sacculus amnii* is formed before the vitellus; on the contrary, the vitellus is evidently to be seen before the cicatricula or chalazæ can be discerned. Next, I deny the chalazæ (if they are canals) to have the least communication with the amnios, at any time, or in any state of the egg, otherwise than as they are both adhering to the membrane of the vitellus, upon which, or within which, no particular fibres, no canals, are stretched to the cicatricula. Every one has it in his power to examine these facts. If then the facts are denied, the consequences cannot be admitted.

Since there are no canals passing through the yolk, that open into the *saccus colliquamenti*, and the cicatricula comes to be placed on the upper
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(a) De Mot. Cord. Prop. ix.

part of the yolk, and contiguous to the air-bag (§ 26.), it is evident, that the *liquor amnii* must be furnished by the chicken, which being covered with feathers, having no mammæ, bladder of urine, or large salivary glands, can only supply it by the branches of the umbilical vessels spread on the amnios.

Harvey (a) affirms, that a liquor is found in the mouth and ingluvies of the chick, which he concludes to be the colliquamentum or *liquor amnii*, from their resemblance; from the quantity of the contents of the stomach; from the chick's being seen to open its mouth; and from the necessity creatures are in of swallowing, or of forcing back by vomiting, whatever is introduced to the root of their tongue.

As to the resemblance, I do not see how the comparison can be made, seeing the liquor in the mouth and crop is in such small quantity, (§ 37.) But suppose that a sufficient quantity was collected, the two liquors agreeing in several properties would not of itself be a sufficient proof of their being the same; and if, for argument's sake, the liquor in the crop was granted to be in very large quantity, and to agree in every property with that in the amnios, it would certainly appear in the same form for some time in the stomach, whereas it is always found very different there in the larger foetus (§ 39.), and Harvey confesses as much in this place: therefore it may be concluded, that it does not go down into the stomach.

If ever any thing like fæces has been seen in the crop of chickens, as has been alleged by some, it might be no more than the yellow or green-coloured substance brought up from the stomach, (§ 39.)

The quantity of the contents of the stomach and intestines may be accounted for from § 38. applied to what was said on viviparous animals.

Though creatures that respire are under a necessity of either swallowing, or forcing back by vomiting, whatever is introduced beyond their fauces, I cannot think it should be thence concluded, that a foetus is under the same necessity; for, as it does not exercise respiration, it will suffer no inconvenience by a liquor lodging near to the glottis: whereas creatures that breathe cannot allow any substance to remain there without danger of the glottis being stopped, or of such substances falling down the trachæa, either of which would be of bad consequence; which the
creature

creature prevents, by forcing such substances out of such a dangerous situation.

But, to enforce the negative of the colliquamentum passing by the mouth, observe, that there are only three days in which this passage can most probably be supposed to happen, which are from the 15th to the 18th day of incubation: for before the 15th, the quantity of the *liquor amnii* is increasing, which is no great sign of its being swallowed; and after the 18th this liquor is not to be seen, *vid.* § 28. If, then, the *liquor amnii* were all swallowed between the 15th and 18th days, the stomach ought to be fuller at this time, and its contents should be thinner, more pellucid, &c. like to the colliquamentum; which I am certain does not happen. Besides, if we suppose the power of digestion so strong as to expel this liquor as fast as it is taken down in these three days, it would certainly follow, that this powerful digestion, continuing in the three succeeding days, while there is no liquor to be swallowed, the stomach ought to be quite emptied; which every one who opens the stomachs of chickens at this time will see it is not. And, lastly, as a more direct proof still against Harvey, I broke the shells of several incubated eggs, while the colliquamentum was in large quantity; and before the amnios was opened, I saw the chickens open their mouths very wide several times, but could not observe the quantity of the liquor in which they lay any way lessened. I afterwards carefully dissected the chickens, and found no other than the common small quantity in the crops, and the ordinary curdy mucus in the stomach; which seems to me a demonstration that they do not swallow.

After such convincing proofs, it will be needless to make any application of the arguments in the former part of this essay to this subject; and therefore I shall only desire the reader to compare the posture of a chick, and of a hen while she swallows liquors, that they may see the posture of the chick's neck to be most unfavourable to the supposition of deglutition being performed; and then shall conclude with a very short history of incubation, assigning what I imagine to be the most probable reasons of the several appearances.

By the heat of the hen, or of stoves equal to it, assisted possibly by the action of the air contained in the *folliculus aëris* (§ 2. 3. 12.), the albumen becomes

becomes thinner, especially where it is most exposed to these forces (§ 14.); and the vitellus in the same manner becomes especially lighter (§ 19.), and therefore readily rises in the white. And as, by being divided into two unequal portions by its axis the chalazæ, it presents the smaller portion to the incubating heat at first, (§ 8. 9.); so the change in consequence of incubation being soonest and most produced here (§ 20.), and the cicatrix being enlarged at the same time, the smaller portion of the yolk becomes of the least specific weight; and therefore is buoyed up to the superior part of the egg, whereby the *folliculus aëris* and membranes of the cicatrix become contiguous when they enlarge (§ 26.), and the vitellus can never be in hazard of compressing the tender embryo; and the umbilical vessels are situated so as to have their extremities immersed in the liquors, that first undergo the proper change, for being imbibed by their orifices, (§ 32.)—The incubation continuing, the white is still more and more colligated, and the umbilical vessels are proportionally extended, the veins to absorb it, and the arteries to throw out any particles that are unfit for the chick till they are farther prepared, but especially to drive forward the liquors in the veins, as was explained in the account of the viviparous animals, (§ 20.)—When the white in the upper part of the egg is exhausted, its membranes become contiguous to the amnios, (§ 15.); and thereby the membranes involving the foetus become sufficiently strong to resist the motions of the chick, when its ease or safety prompt it at any time to spurn.—The powers of incubation above-mentioned, assisted by the pulsation and conquassatory motions of the numerous umbilical vessels spread on the yolk (§ 32.), dissolve that humour more, and render some part of it fine enough to be taken up by the small extremities of the umbilical vein, some of which penetrate its membrane: By which the liquor at last becomes thicker (§ 20.); and the membrane, being in part emptied, will more easily yield to the weight of the chick; and is pressed into the form of a horse-shoe (§ 21.), while the net-work of vessels extended on this membrane render it stronger and firmer.—The *folliculus aëris* not only assists in colligating the albumen; but, when the humours of the egg come to occupy a less space, by escaping through the shell (§ 24.) and by being changed into the solid substance of the chick, the folliculus enlarging (§ 12.) keeps the chick and humours steady,

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without danger of being disordered and broke by the motions of the egg. —Branches of the umbilical vessels being distributed to the amnios, (§ 32.), the arteries will pour out their liquors into its cavity in greater quantity than the veins can take them up, as long as the foetus is weak; but, whenever the foetus becomes stronger, and consequently the absorbent power of the veins increases, (vid. § 15. of Sect. I.), they will take up the fluid of the amnios faster than the arteries pour it in, and its quantity will be diminished till it is quite exhausted (§ 28. and 29.) —This absorption will go on more speedily in proportion also to the umbilical vessels being less distended with albumen, whereby there is less resistance to the progressive motion of the absorbed liquors; which probably is the reason of the colliquamentum being all taken up between the fifteenth and eighteenth days.—By the constant circulation and renewal of all these humours of the egg, they keep fresh and uncorrupted in a fecundated egg, (§ 17. and 22.); but corrupt soon in a subventaneous one, or in such whose foetus dies in the time of incubation.—Wherever vessels are not sufficiently filled, they contract themselves; and therefore, the albumen being exhausted in the last days of incubation, the umbilical vessels gradually shrivel (§ 33.), which prevents the danger of an hæmorrhage when the chick is separated from its membranes. But, as the white is not sufficient at this time fully to supply the chick, the yolk is taken into its body (§ 23.); and being there pressed, it is thrown gradually by the proper duct (§ 23. and 44.) into the guts, to supply that defect.—The vessels and glands which open into the alimentary tube separate at least as much liquor as will moisten it; and, the stomach having no callous strong crust on its internal surface, (§ 38.); will separate more than it can do in the adult; and in the mean time the glands of the infundibulum pour out a liquor that is always thicker as the chick increases, till it becomes a very thick white mucus: And therefore the contents of the stomach of the foetus in the egg must have the appearance described (§ 39.), and will be slowly passing off into the intestines.—The shell at the obtuse end of the egg becoming more brittle, by being so long exposed to a dry heat (§ 1.), and the membranes losing their toughness when their moisture is exhausted, the chick very easily tears them, and breaks off that end of the shell, to make its way into the common atmosphere.—The mother

having no juices prepared within her body to give to the chick for food after it is hatched, and its organs for taking in and digesting aliment being for some time too weak to supply it sufficiently with nourishment, the vitellus is made to supply these deficiencies, till the chick is sufficiently confirmed and strong (§ 44.); after which, it is no longer the subject of my present inquiry.

Of the Nourishment of Plants while in a Fœtus State.

THE first eight numbers of the following facts are taken from Mr Geoffroy (a); and all the others, except one or two observations of my own, are collected from Malpighius (b).

1. Flowers contain the male and female organs of generation of plants.
2. The male organs are small bladders (the apices), full of a very fine dust; each particle of which is of a particular distinguished form in each species of plants.
3. When this dust or farina is sufficiently ripe, the bladders break with an elastic force, and throw the dust from them.
4. The female organ is the stylus, pistillum, or tuba, consisting of several canals, which are open and wide at one extremity; but in the other, nearest to the stalk of the plant, terminate in one or more cavities, where small roundish ovula are contained.
5. Both organs of generation are contained within, and protected by, leaves of different make and colour in different plants; which leaves are generally called the *petala* of flowers.
6. Some flowers contain both the male and female organs, and therefore are called hermaphrodites; others only contain one or the other kind, and thence are named male or female.
7. Those flowers which are only male or only female, either grow both from the same root, or the male only grow on one plant and the female upon another of the same species; from which such plants are said to be male or female.
8. When the male farina, or dust, is prevented from having access to
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(a) Mem. de l'Acad. des Sciences, 1711.

(b) Anat. Plant. cap. *de feminum generat.* et in tractat. *de sem. veget.*

the female organs, either the ovula do not increase into seeds, or, if they do grow, they are deformed, do not contain any germ or rudiment of the young plant, and are not prolific.

9. When the fecundated ovula increase, the germ or young plant of each is seen lodged in a pulpy substance named the *feminal leaves*; which again adhere to, and frequently are sunk some way into a depression of a membrane, which forms a little bag for containing a liquor; and therefore this bag is called the *amnios*.

10. From this side of the amnios, opposite to that where the germ, with its *feminal leaves*, is fixed, a tube (the *umbilicus*) goes out to be continued to the uterus.

11. Before the umbilicus reaches the uterus, it passes through a cavity formed by another membrane that is full of liquor, or contains a great number of small vesicles distended with liquor; and therefore is compared to the chorion.

12. The chorion and amnios become more and more turgid with liquors for some time; but then the liquors begin to diminish, the chorion being soonest emptied, and the navel-string shrivels away till it can no longer be observed.

13. In the mean time the germ and feminal leaves increase apace.

14. At last all the liquors in the chorion and amnios are consumed; their membranes contract and shrivel; the seed is sufficiently large and confirmed; the small peduncle, by which it adheres to the uterus, shrivels, turns hard and brittle, and the seed falls off with the least force.

15. The seed is composed of its membranes or teguments, of a large farinaceous part, and of the small germ joined to the farinaceous substance by a small peduncle, which is inserted into the germ between the caulis, stalk, or plume, and the radicle or small root, of this young plant.

16. The germ is evidently the young plant, where the plume and root may plainly be seen.

17. When the fecundated seed is sowed at the proper season, the farinaceous substance soon becomes softer, and the germ stretches its stalk upwards and its root downwards.

18. The farinaceous substance either remains under ground, turning larger for some time, but having its substance changed more and more

into a milky liquor, or it is extended upwards in form of one or two pulpy juicy leaves: From these different forms which this farinaceous substance takes, it is called the *cotyledons*, *feminal leaves*, or *lobes*.

19. After some time the lobes begin to shrivel, and to have their liquors consumed; and at last, when their juices are all wasted, they fade away and fall off.

20. The plant grows very fast all this time.

21. When the cotyledons are taken off before the plants are put into the earth, scarce any of them will vegetate, and all perish very soon.

22. Those that advance any, after being thus deprived of their cotyledons, increase rather in their plume than root.

23. When the feminal leaves are taken away, after allowing the plant to vegetate so far as to come above ground, it perishes in a little time, the roots generally fading first.

24. If the cotyledons are taken away later, most of the plants die, and those that continue to grow are always very small.

25. When only one cotyledon is taken away, the plants do grow, but are not near so large or strong as the others that are left entire.

26. By taking away the plume, when it first sprouts above ground, the roots grow very large and quickly.

To fix an analogy here between animals and plants, it will be necessary to determine how long either of them should be said to remain in the state of a foetus: which, in my opinion, ought to be understood so long as the young creature is nourished solely by liquors furnished by the uterus of the parent; but as soon as it is supplied any other way with all or any part of its nourishment, it can no longer be looked on as a foetus.

If this is agreed on to be the distinguishing character of a foetus, it will be evident, that we are only to regard plants as foetuses while the seed is ripening, and before the earth, water, moisture of the air, &c. have communicated immediately any matter for its increase: and in this case it will appear most probable, that the umbilicus pours in liquors from the uterus and chorion into the amnios, from which it is taken up by the vessels of the feminal leaves, to be conveyed partly into the foetus, and partly into the leaves themselves; by which the plant is increased, and

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its parts are explicated, and a substance is provided for nourishing it afterwards, when its tender roots either can receive from the earth very little, or any thing less than is necessary for the sufficient growth of the plant.

In running this analogy between animals and plants, you will observe a mixture of the mechanism of the viviparous and oviparous animals in the nourishment of the foetuses of plants. For the little plant having, as in the viviparous animals, a communication with the uterus of the parent till it is fully formed, the whole quantity of the liquor it is to be nourished with is not at first to be seen, as the albumen is in the egg; but the uterus furnishes the liquor to be gradually absorbed by the cotyledons or placenta: And then, on the other hand, plants resemble the oviparous animals, in so far as the parent being incapable of supplying any juices prepared in its own body, after the foetus is separated from the womb, for the nourishment of the plant; and the young plant not being in condition, for some time, to subsist entirely on the new nourishment it must receive; the farinaceous cotyledons, or pulpy seminal leaves, do the same good office to the plant as the vitellus does to the chick after it is hatched.

Since the resemblance is so great between animals and plants, it would be superfluous, after what has been said of the former, to enter into a particular detail of the reasons of the foregoing phenomena of plants; and it is almost needless to say, that I would conclude both the oviparous animals and plants to favour my opinion, of the whole nourishment of all foetuses being conveyed by particular absorbent vessels, and not by the ordinary canals through which the aliment must pass after the creature is out of its foetus state; for these are obvious to any who reads these essays with the least attention.

Practical COROLLARIES from the preceding Essay.

BEING conscious to what length the essay on viviparous animals had run out, I did not intermix any account of morbid phænomena with the description of the parts, or with the arguments concerning the nourishment of the fœtus, which also would have had the bad effect of diverting the reader's attention from the principal design: but considering how much such phænomena may serve to explain, and possibly confirm, some part at least of my reasoning, and knowing how ill any thing that is not practical goes down with some people, I beg to be still further indulged, while I bring a few examples to shew, that the knowledge of the structure of the parts is absolutely necessary for understanding the nature of diseases; and that all theory is not mere idle speculation, but that reason and experience united lay the surest foundation of the practice of physic.

I. Seeing the vessels of the womb and of the placenta do not anastomose (§ 16.), and women have an erect posture, and are subjected to periodical evacuations from their uterus, which has larger canals opening into it than are to be observed in other animals (§ 2. 3. 4. 5.), we may understand how much more liable women are to suffer abortions, than the females of other creatures are. For, the contents of the impregnated human uterus press more on the orifice of the womb to force it open; the superfluous quantity evacuated periodically at other times, is apt to thrust off the placenta; and, being poured into the cavity of the womb, either corrupts there, or forces open the *os uteri*; both which will probably occasion the loss of the fœtus: whence women much more seldom conceive immediately before the menses are to flow, than soon after that evacuation is past. Thence also we understand why loosening, as the women call an appearance of blood from the uterus, is a symptom that discovers great hazard of abortion.

II. Nature endeavours to provide against the inconveniencies mentioned in the preceding paragraph, by making the placenta adhere sooner to the human womb than is ordinary in other creatures; and by furnishing the human foetus with a larger proportional placenta, whereby the adhesion is stronger, and on both accounts the evacuation is prevented.

III. When there is the largest quantity of the superfluous liquors collected, the strongest push must be given to separate the placenta from the womb; but the menses are generally stopped after pregnancy, and the child is too small for some months to consume them; wherefore women are most exposed to abortions in the third or fourth month of their going with child.

IV. We see what disorders are brought frequently on women at each period when their menses are about to flow, and what mischiefs almost constantly attend their obstructions; and therefore need not be surpris'd at the fainting, nausea, reachings to vomit, &c. that so often attack women in their first months of pregnancy: some of which help to remove and prevent other disorders; for by the vomiting, for example, not only an evacuation is made, but less chyle must be sent into the blood-vessels, which therefore will have less of the superfluous liquors. This again teaches us to remove or mitigate such symptoms, when they become very violent and dangerous, by proper evacuations.

V. Since the separation of the placenta from the womb must so evidently produce abortion, we may see that this may be occasioned by very different causes, operating in various manners, and requiring very different treatment in preventing the loss of the foetus, when our advice is asked timely.

1. Whatever occasions too great a quantity of blood to be sent to the uterus, or assists or increases its momentum to thrust off the placenta, such as plentiful living, compression of other large vessels, frights, violent exercise, shocks of the body, fevers, &c. will bring a woman into danger of abortion. The cure, however, is plainly pointed out; to wit, blood-letting, mild food in small quantities, and rest.

2. When the adhesion of the placenta to the womb is too weak, and the *os uteri* does not make a sufficient resistance to its own dilatation, whether these depend on the ordinary general constitution of the body, or on a particular

particular disposition of the womb, or on a sudden relaxation, as in fainting, the same bad effect, abortion, may still follow; but the cure must be very different from what is to be used in Numb. 1. For here we must rely on corroborants; and though much exercise is at first to be shunned, yet if the patient can by degrees be brought to bear moderate exercise, it will assist the other medicines considerably.

3. If the sinuses of the womb are allowed suddenly to collapse, by the want of a large enough quantity of liquors to distend them, as by the necessary supplies to the blood being withheld, or by violent evacuations, especially loss of blood, not only the weakness mentioned in Numb. 2. may follow; but the vessels of the placenta, which have not been proportionally emptied, will be disengaged from the excretories of the sinuses, by their being deprived of sufficient space to lodge in, and there is great danger of abortion. In such a case we are to be on our guard not to apply smart stimulants to rouse the languid mother too hastily; for such medicines increase the contraction of the vessels of the uterus, and will drive off the placenta soon: but we ought to repair the quantity of her blood by mild balmy food, with a mixture sometimes of the least irritating cordials.

4. All causes that can produce a strong contraction of the fibres of the uterus, or of the parts that can press upon it, as, for instance, of the diaphragm and abdominal muscles, will be in danger of forcing away the placenta, and of opening the *os uteri*, whereby abortion is occasioned. Therefore sharp pains in any part of the body, and especially in or near to the uterus, rough emetics, sharp acrid purges, tenesmus, strangury, piles, or such like, are every day bringing on abortion. The radical cure is certainly to remove the cause of the pain or irritation, which must be done by medicines adapted to its particular nature and seat, which are too numerous to be mentioned here. If this cannot be executed so soon as we would desire, we are to lessen its bad consequences as much as possible, by blunting its violence, and counteracting its effects. The first of these indications will principally and most speedily be pursued in most cases, (except perhaps in the inflammatory ones), by giving opiates. The second intention is answered by diminishing the momentum of the blood, which venæsection effectually does, and is always useful in the inflammatory

tory cases ; but is not so proper in some other circumstances, where however the opiates generally answer our intentions.

VI. The liquors sent into the foetus by the umbilical vein not having their propelling force communicated from the mother (§ 16.) the state of the mother's pulse cannot affect the child otherwise than by the occasioning abortion, or vitiating the fluids that are to be absorbed ; and therefore we may be convinced, how vain it is to pretend to account, in a physical way, for the impressions said to be made on children by the imaginations of the mothers. We may hence also see, that children may be infected with the diseased juices of the mother ; but that it is possible for them to escape catching the diseases of their mothers, if either they are only topical, without affecting the whole mass of fluids ; or, even when the mother's blood is spoiled, the child may be free of her disease, if the morbid particles are such as the placental vessels cannot absorb. This you see is in some sense giving the vessels a power of choosing good or bad.

VII. The placenta is largest proportionally in the youngest foetuses (§ 18.), by its being less capable of yielding to the stretching power of the contents of the uterus, than the membranous parts of the secundines are ; and thereby it is better calculated for the greater proportional growth of the foetus when young.

VIII. Though the surface of the placenta is not extended proportionally to the increase of the foetus, yet the orifices of the sinuses seem to keep up to that proportion (§ 5.) : therefore the surface of contact between the uterus and placenta rather decreases than turns greater ; and a greater quantity of fluids is applied to that surface. Which may be one reason why the after-burdens of ripe children are brought away more easily than those of abortions.

IX. By being acquainted with the muscular structure of the uterus (§ 6.), we come to know how the placenta separates more easily after the child is born, than while it is yet contained in the uterus. For, as long as the child remains there, the womb is hindered from contracting, upon which, and the want of a muscular contraction in the placenta, the separation of the after-burden depends. And since the degree of contraction of the uterus will be proportional to the distraction of its muscular fibres, as

happens in all muscles, we may see another reason why the after-burdens of abortions are more difficultly brought away than those of ripe children; and we may observe, how reasonable the use of *pulv. ad partum*, or other cordial stimulating medicines, is, in such cases, to hasten this contraction, when there is not some stronger contra-indication, such as fever or inflammation, to forbid their use.

X. The sinuses of the human womb (§ 3.) are much more safe and useful than any continued arterious canals could have been : For these would have occasioned too great an hæmorrhage when the placenta was separated; whereas, in the way the small branches of the arteries are disposed upon the membranous sides of the sinuses, they must be compressed as soon as the uterus contracts; and at the same time, the resistance which the womb occasioned to its own returning blood by its pressure on the large veins, being taken off when the womb collapses, the lateral branches of the minute arteries can be very little distended with blood, and the sinuses will be very little filled. To illustrate this, remark a very analogous case, the œdematous swellings of the legs in women with child, which go off as soon as they are delivered. Hence we may be convinced, that the only means whereby we can save a woman's life, whose placenta separates before birth, is to deliver her immediately. And hence it is plain, why the lochia or cleanings gradually diminish in quantity, and lose their red colour.

XI. Seeing the resistance to the blood in the descending aorta is taken off upon delivery; and that not only the placenta separates with more difficulty when the womb has not contracted itself, but also a greater hæmorrhage must happen; it will appear no wonder that weak women should be so liable to faint at this time, especially if they have been kept in an erect posture, and the midwife is too anxious to bring away the placenta soon. Hence we ought to learn to deliver such lying in a bed, or on a couch; and the uterus ought to be allowed some time to contract, and the mother ought to have time given her to recover the fatigue of her throes, before the after-burden is brought away. Hence also we may be convinced, how necessary soft compression by bandage is on the belly after delivery.

XII. When the quantity of the mother's blood is small, or when the
con-

contraction of the uterus is very quick, or when an obstruction happens in the arteries of the sinuses, the cleanings will be in very small quantity. The constitution of the patient, and the state of the pulse, readily discover what the want or too small quantity of the lochia depend on; and, in the first supposition, there is no harm from this stoppage, but we do mischief if we attempt to force them; but, in the other cases, we ought to encourage this evacuation by soft relaxing internal medicines, and by injections, fomentations, &c. applied to the womb, or near it, while other evacuations are promoted or made if the symptoms become urgent.

XIII. The liquor of the stomach being so thick (§ 30.) while all the digestive powers of a child are very weak at birth, we may easily understand what bad consequences, such as its sticking to the guts, obstructing the orifices of the lacteals, &c. may be produced by this mucus remaining there; and therefore ought to admire the wisdom of our Creator, who has provided such a thin diluent purgative milk at this time, for preventing these disorders; and may hence learn how necessary it is to cleanse the *primæ viæ* of new-born children by proper medicines, especially when they are not suckled by their mothers, and have not a nurse whose child is as young as themselves.

XIV. The want of respiration to squeeze forward the bile, and the resistance made to its entry into the guts of foetuses, by the tough slime which lines the intestinal tube, make the effusion of their bile very slow; and therefore their gall-bladder is generally full of a green sharp bile. Hence at birth, or soon after it, children are often observed to have the jaundice, the thick slime producing the same effects in them as is disputed for from stones *. This jaundice generally yields to any gentle purgative, and very often is carried away by any medicine that increases the contraction of the guts; which is no more than might be expected from understanding the cause of the disease. It is also from this collection of bile during gestation, that children are so frequently subject to gripes and green purging soon after birth, which cleanses their guts of the unnecessary slime and meconium, and discharges that sharp bile, which might bring on disorders of worse consequence if it continued to lodge

3 K 2

there:

* See No 38. of this COLLECTION.

there: So that, however troublesome it may be to the innocent babes, they are generally the better for it afterwards.

XV. From the care bountiful Providence is at, not only to supply a sufficient quantity of nourishing juices to the foetuses of animals and plants, but also to furnish substances prepared by the mother's organs, for serving them after they are separated from her, viz. milk in the viviparous, the yolk in the oviparous animals, and the farinaceous substance of the seeds in plants; and from what we observe of brutes, who follow the dictates of nature more closely than man does, how they only gradually come to use the common food of their parents; we may be convinced, that the food provided by nature, milk, is the most proper for infants; that a sudden change of food is dangerous to such tender creatures; and that therefore the food given children when they are to be weaned from the breast should be such as is nearest to milk, and the breast ought to be taken only by degrees from them. By which method I have often prevented all the troublesome disorders which generally attend weaning.

XVI. From what was remarked above (§ IV.) of the disorders women are frequently subject to when their menstrua are about to flow, we may rationally conclude, that a nurse, who has such a redundancy of superfluous liquors, will have her milk changed to the worse. And, from what all practisers in physic have observed of the effects of deriving a more than ordinary quantity of our juices to one part, in order to make a revulsion from another, we have reason to think, that a nurse, whose menses are brought on by any other cause than a superfluity of liquors, will come not only to have less, but also worse milk, after such an evacuation; and therefore a nurse who menstruates ought not to be chosen. But if particular circumstances oblige us to continue a child with such a nurse, we ought to consider the causes that occasion her menses to flow; and according to these, we are to order the child to be kept up from the breast, either before the evacuation in the first supposition, or for some time after it when it has been brought on by any other cause.

Nº 13.

R E M A R K S

O N T H E

COATS of ARTERIES, their DISEASES, and particularly
on the Formation of an ANEURISM *.

THE curious and accurate account of the aneurism, which was shown to me, before it was sent you, by a gentleman to whom I stand indebted for many obliging acts of friendship, and Mr Macgill's desire that I would endeavour to explain the nature of this disease, which appears neither to have been exactly examined, nor rightly understood, by chirurgical writers, have given rise to the following remarks on the coats of arteries, their diseases, and particularly on the formation of the aneurism; and, as a sequel to this, I shall afterwards lay before you some figures of the arteries of the arm, accompanied with a few reflections on the aneurism occasioned by venæsection, which is by much the most frequent that admits of any cure.

In several parts of the body, arteries receive a strong firm covering from the contiguous parts, which has been described as their exterior coat; such as, the membrane that furrounds the aorta while it is within the pericardium, the pleura and peritonæum spread over the descending aorta in the thorax and abdomen, &c. But seeing this coat is only to be observed in some parts, where particular purposes are to be served, such as strengthening an artery where it is more than ordinary exposed to the stretching force of the circulating fluids, counteracting the resistance made by some solid body on its opposite side, saving it from compression, &c.

I

* Originally printed in the Edin. Med. Essays, being Art. xvi. of Vol. II.

I think it ought not to be considered when we speak of the coats of arteries in general.

All arteries are covered externally with a cellular substance, composed of very fine pellucid membranes, which are capable of being stretched, even suddenly, to a great extent without breaking; and they collapse as quickly when the stretching force is removed. There is always more or less of an oily liquor contained in the communicating cells of this substance; and the proper vessels of the arteries run in it, spreading branches every where on the cells for the secretion of that oil. When either the membranes are distended by a liquor thin enough to enter the cells, or when the exterior part of the membrane is gently drawn, the cellular texture is evident: but when a gross substance is forced into the more internal part of this cellular membrane, it conceals the fine threads of the membranes mixed with it; and whenever the cells are empty, they collapse so close together, that the whole appears to be one membranous coat, consisting of several layers.

All arteries are surrounded with such a substance as I have just now described; and therefore it may be reckoned one of their coats: Though I must observe, that the same kind of cellular substance is common to at least all the flexible parts of the body, where every little fibre is connected to another by the same contrivance. See Boerhaave's preface to his edition of the *Autores varii de morbo Gallico*.

This cellular substance of the arteries serves to connect them to the surrounding parts, without hindering or disturbing their actions or motions; it prevents their being so readily compressed; it gives a safe passage to the vessels of their other coats; it contains oil for lubricating and keeping the interior coats flexible.

What really deserves to be called the first proper coats of the arteries, is the muscular or tendinous; which, in the human body at least, consists of annular fibres connected strongly together. It is to these principally that the recoiling of an artery is owing, after it has been distended by the superior force of the systole of the heart; and the elasticity of the substance connecting the annular fibres, which is of the cellular kind, is very remarkable in the quick contraction of an artery after it has been stretched longitudinally.

The most internal coat of arteries cannot be rightly observed while they are found and recent; because it is so thin, and adheres so firmly to the muscular coat, that it appears in form of a very thin layer of longitudinal fibres: but after the arteries are kept some time, and their texture becomes more easily unravelled by the beginning putrefaction, it separates very easily, and shows numerous inequalities on its interior surface, with vessels dispersed on it; and a cellular substance is seen connecting it to the muscular coat. But there is no appearance of any muscular structure in it, and it tears very soon upon attempting to distract or stretch its fibres; so that it would seem to bear a very strong resemblance and analogy to the villous coat of the intestines, whose proportional greater distensions and contractions above what arteries ever suffer, and thicker *tunica cellularis interna*, will account for the papillæ and rugæ so much more observable in the guts than the arteries. I suspect it must be this coat which Mr Winslow (*a*) calls the *duvet*, which he affirms he saw filling up the cavity of the small fecerning arteries of the glands, and on which he builds his account of secretion. I imagine it a membrane analogous to this, which, divested much of its cellular substance, forms the valves in the veins.

This interior coat will prevent any particles of our fluids from insinuating themselves into the cellular substance of the other coats; it renders the surface of the arteries more smooth and polished than otherwise it would be; and we may conclude, from the analogy of other parts, that its vessels separate a liquor to protect and lubricate its own interior surface.

FROM the texture of the external cellular coat of arteries, as above explained, it is evident, that obstructions are very apt to be formed here; which, according to the different series of vessels in which the obstruction is, and the different natures of the obstructed liquors, will produce various diseases, as well as in the *tunica cellularis* elsewhere in the body, which is the seat of numerous diseases that are said by authors to affect other parts. To take but one example of the many which Boerhaave (*b*) names: Here it is that inflammations are placed; this it is that melts down.

(*a*) Mem. de l'Acad. des Sciences, 1711.

(*b*) Præfat. in Autores de Morbo Gallico.

down into pus in all suppurations. Let surgeons reflect, whether ever they saw the proper muscular fibres dissolved into pus; or if firm membranes, ligaments, the skin, &c. do not cast off in sloughs, when they are eroded. Let those who examine the bodies of people dead of pleurifies, inflamed guts, &c. remark, whether the membranes said to be affected are not entire, and the pus is not collected in the cellular substance under the membrane. But, to return to the present subject, the diseases of the external cellular coat of arteries may serve to diminish the diameter of the artery, if they compress it. If the oil in the cells becomes too thin, or only lymph is contained in them, the muscular coat may be too much relaxed. If there is too small a quantity of the moistening liquors, the artery loses that flexibility that is necessary for it: And if the morbid matter becomes acrid, it may erode or destroy the muscular coat; though this will be done with difficulty, because of its firm texture. Hence we daily see large arteries long soaked in the pus of abscesses without any hæmorrhage.

The muscular coat will be subject, as well as other muscles, to too great rigidity or laxity, to convulsive contractions, or paralytic affections; though these will not show themselves evidently, because of the action of the heart upon the artery, and of the elasticity which this coat has, independent of the circulation.

What was said of the texture of the most internal coat, will naturally lead one to think that it must be subject to diseases, and that these will be much a-kin to the maladies of the external cellular coat; allowance only being made for the violent compression which the internal one must always suffer, from the impetuous stream of blood on one side, and the brisk reaction of the muscular coat on the other; the effects of which may be readily enough understood from what I have had occasion to say elsewhere (a) on such compression. It is only in the cellular membranes of this interior coat that ever I saw any of the bony or calculous concretions of arteries. I have more than once observed the cavity of a large artery almost blocked up by a steatomatous thickening of this coat; and frequently I have observed purulent matter collected in it.

Notwithstanding

(a) Accounting for ossification in the Anatomy of the Human Bones. *Vide* N^o 3. of this Collection.

Notwithstanding the morbid state of this coat, and of its cellular membranes by which its connected to the muscular coat, offers itself so frequently to the view of those who dissect the human body, practical authors and observers have not been at pains to remark how far the animal œconomy was thereby disturbed, I offer the few following conjectural queries to their consideration. May not diseases here often occasion great inequalities and irregularities of the pulse? May not a *tabes purulenta* have its seat here, without any bowel being affected? Will not a small erosion of this coat, and a consequent oozing of the blood through the cellular texture of the other coats, more naturally account for the ecchymoses that happen so frequently in diseases, where the blood is acrid, than breaking of the vessels can do? Are not the small vessels, where the motion of the fluids is slowest, more liable to suffer this erosion than the larger ones are?

The preceding account of the coats of arteries may let us see, that no aneurism can happen, unless through some fault of the interior coats; therefore it will be necessary to take a view of the several ways these coats may be so vitiated, as to give any chance for the formation of an aneurism.

1. A large opening made into an artery, with a proportional aperture in the teguments, produces only an hæmorrhage: but, if the external orifice in the skin is so small, as not to allow the blood to escape as fast out at it as it flows from the artery, the neighbouring cellular membranes will soon be filled with blood; the member becomes every where swelled and discoloured; and, in short, what is generally called a bastard aneurism is formed.

2. If the aperture into the artery is very small, and the blood cannot escape through the teguments, it will coagulate before it can be pushed to any considerable distance from the orifice by which it escaped; and thereby an obstacle will be made to the succeeding blood's spreading in the *tunica cellularis*, which soon will be formed into a lamellated membrane, by the oil being squeezed out, while the extravasated blood becomes firmer and harder, so as to appear of the polypous consistence, by the pressure it suffers. I had sometimes occasion to be much surprised at seeing how soon such a change can be brought on the arterious blood; the instances I mean are, where, after a limb was amputated, the patient's

faintness hindered the arteries to spring as usual, by which one lay undiscovered, and was not stitched; but, in a few hours after the dressings were put on, occasioned an hæmorrhage, notwithstanding the bandages had been tightly applied, and a prentice pressed strongly with his hand on the end of the stump. When the wet dressings were removed, I saw the clotted blood on them become firm, of a pale colour, and having the appearance of a fibrous texture. Since then such coagulated blood is contained in a membranous substance, the disease, in the case we have supposed, will have the appearance of a circumscribed encysted tumour, which the pulsation of the neighbouring artery and the jet made at its open orifice will communicate a pulsation to, till either the bulk of the swelling, the quantity of liquor below the coagulum, or the great resistance of the parts stretched on the tumour, render the vibration imperceptible; and, till once the polypous concretion turns very large, the tumour will become much less on compressing it strongly, by the fluid blood being forced back into the artery through the perforation in its coats; that is, a tumour, attended with all the symptoms of what is called a *true aneurism*, is formed, though the principal part of the ordinary definition, viz. the distension of the proper coats of the artery, is wanting.

3. If the muscular coat is only perforated, the interior coat will be pushed out at the interstice of the divided fibres; and not being capable of being stretched far without breaking, the case is soon reduced to one or other of the two former suppositions.

4. If part of the muscular coat only has suffered a solution of continuity, the remaining fibres are either able to resist the force of the blood without being distracted beyond their natural tone, in which case they will reunite, especially if they have been divided by a sharp instrument cutting transversely; but, when there is loss of substance, or a longitudinal incision, the breach can only be made up by syssarcosis; but in neither case will either sort of aneurism happen, unless more fibres afterwards yield to bring it to be no longer able to resist the impetuous blood, as I think would for most part follow, from what I have seen in trying some experiments for observing what happens in an artery taken out of the body when it is filled with quicksilver and pressed, after some of the muscular fibres have been cut or broke. If either, then, the fibres continue

to break gradually, or the distension of them is sudden, when all are torn, the disease is reduced to the supposition made in § 1. and 2.

5. When part of the fibres are broke, cut, or eroded, (any of which ways you may conceive the solution of continuity to be made on all the suppositions yet mentioned), we can imagine such a proportion to remain entire, as being very near, but not altogether, able to resist the fluids, will yield very gradually, and form a true aneurism, in the sense the common chirurgical books explain it: But, besides the many chances against such a precise approach to an equilibrium happening between a lesed artery and its contained liquor, I must observe, that, though membranes become stronger and thicker as they are gradually stretched, yet muscular fibres separate more and more, leaving larger interstices: And therefore, if the annular fibres of an artery were thus separated, the interior coat would soon yield in their intervals, and the blood would burst out to form one or other of the tumours described in § 1. and 2.; and when it is confined, as in § 2. the circular fibres would appear like so many columns or cross bars in the tumour; which agrees very well with several descriptions of aneurisms handed down to us.

6. If a small part of the muscular coat of an artery loses its natural tone, or contracting force, by any paralytic disorder, it will yield to the stretching force of the blood; and thus an aneurism may be formed, which will have all the characters of what is commonly named a *true aneurism*. You see, that a partial palsy, and that very gradually coming on, must be here supposed; otherwise the fibres being separated, and the internal coat breaking, will reduce it soon to the state mentioned in § 5.: And indeed it would appear from what is there said, that, before it becomes of any very considerable bulk, we have reason to judge the same would happen here. Besides, such a palsy as has been here supposed will very rarely be formed, because of the great sympathy and connection which the whole arterious system has, the pulmonary artery and aorta making each one hollow muscle continued from the heart to their small ramifications: And I believe a palsy is seldom or never observed to affect only one extremity, or the middle of a muscle, while the other parts of it continue to be vigorous and active.

7. The only supposition we need make concerning the interior coat of

arteries alone being affected, is a solution of its continuity; which will readily happen by all sudden overstretching of an artery, or it may be made by any eroding causes, such as suppuration, &c. I cannot say positively, that the want of this coat is capable of producing an aneurism; but shall offer a conjecture, which may possibly be improved afterwards by observation. It is this: When this coat is removed, some particles of our liquids may insinuate themselves into the cellular membrane connecting the muscular fibres; and, gradually enlarging these passages, may at last penetrate through it, to be diffused in the external cellular coat: And thus at length this case is reduced to what is mentioned towards the close of § 5. I was brought into this way of thinking, partly by observing how readily cellular membranes transmit liquors, and by seeing air escape through all the other coats of the guts when the villous one is removed.

From the whole we may see, that what authors call now a-days a true aneurism will very seldom be formed: which may be still further confirmed by mentioning the remoter causes which are agreed on by all to occasion it for ordinary; these are, wounds, bruises, straining, loud laughing, crying, &c. All such, you see, make a sudden violent effort on the arteries, and therefore do not rightly answer to any of the suppositions we made of the manner this disease could possibly be brought on. And, to establish what you see I argue for, of the true aneurism being a very rare disease, I perused a great number of histories of aneurisms, besides those mentioned by Dr Freind (a), and could not find above two or three that were dissected, so much as alleged to have been true aneurisms; and there was not one, where it is said that the aneurismal sac consisted of strong annular muscular fibres; which must, however, be the true criterion whereby the true aneurism can be known, seeing from what was said in § 2. confirmed by several accurate histories, blood, extravasated in the *tunica cellularis*, will have all the other symptoms that are described as proper to the true aneurism.

(a) History of Physic, Vol. I.

Nº 14.

R E F L E C T I O N S

O N T H E

ANEURISM occasioned by BLOOD-LETTING.

THE engraved figures will give a better idea of the situation and course of the arteries of the arm that are the subject of the following reflexions, than any words can; and therefore, without adding any verbal description, I shall proceed to the explication of the plate.

PLATE II.

Fig. 3. represents the most ordinary distribution of the humeral artery.

1. A part of the pectoral muscle.
2. The *biceps flexor cubiti*.
3. The *coraco-brachialis* muscle,
- iv. The *brachiaëus internus*.
4. The *brachiaëus externus*.
5. The *brevis* and *longus extensor*.
6. The *pronator radii teres*.
7. The *supinator radii longus*, and *extensor carpi radialis* drawn outwards by a thread.
8. The *supinator radii brevis*.
9. The *flexor carpi radialis*.
10. The common origin of the *palmaris longus* and *flexor carpi ulnaris*.

A The trunk of the humeral artery giving off branches in its course to the neighbouring muscles.

B The place below the joint of the elbow, where it is about to split into its two large branches.

C The

C The radial branch.

D The common trunk of the ulnar and median arteries.

E A branch going off from the humeral artery above the elbow toward the internal condyle, behind which it anastomoses sometimes by a large canal with a branch sent up from the ulnar, oftner they communicate by a great many small branches, and frequently I could not discover any conjunction of these two arteries.

F The part of the humeral artery, where it commonly begins to be covered by the aponeurosis of the biceps muscle.

G A branch sent up from the radial artery behind the external condyle of the *os humeri*, to anastomose with such a branch of the humeral artery as E is.

The same parts are pointed out in the three following figures, by the letters and ciphers employed in the first figure, which makes a repetition of their explication needless.

Fig. 4. Is borrowed from Mr Cowper's Scheme of Arteries *.

a Is a branch sent off from the humeral artery, to anastomose, behind the internal condyle of the humerus, with the artery *b* which comes from the trunk of the ulnar and median arteries.

H The ulnar artery.

I The median artery.

k Branches given to the muscles of the hand from the humeral artery, just as it is about to split into its branches.

Fig. 5. Shows the humeral artery dividing into two great branches as it is coming out from the arm-pit. These branches are represented as if they lay at each others sides, which the oblique view I gave of them to the painter obliged him to; but the one *c* which afterwards becomes the radial, is placed directly anterior to the other in the subject, the ulnar *d* lying pretty close to the bone.

Fig. 6. Represents the humeral artery splitting near the middle of the arm, *e* being the larger anterior more superficial branch, which goes on to divide as the humeral artery in fig. 3. does, while the lesser branch *f* runs

* Appendix to the Anat. of Human Bodies, tab. iii.

runs close on the bone to open into the common trunk of the ulnar and median arteries.

H The ulnar artery.

I The median artery.

L The branch marked *b* in the fourth figure.

Not. The muscles 6, 9, 10, are here cut through, and hang over the cubit, while those marked 7 are drawn outwards, that the arteries might be distinctly seen.

I still preserve the arms represented by fig. 3, 5, 6.

By the distribution of the humeral artery in fig. 3. it would appear, that the artery, which is in hazard of being hurt by the lancet in blood-letting of the arm, is for ordinary the trunk of the humeral artery; and that the lancet must pierce the tendinous aponeurosis of the biceps muscle before it touches the artery. To be still more assured of this, I pushed pins into the arms of several bodies at the ordinary place where the basilic vein is opened, and where the cicatrices of former venæsections were seen; and, allowing the pins to remain there, I dissected the parts, till I saw what has been above asserted to be true.

Sometimes, when the median vein is opened lower than ordinary, the radial artery may be hurt; but then its wound must be so near its rise from the trunk, that it is impossible to make any ligature on the radial artery above the aperture; and therefore, seeing the humeral artery must be tied, if the operation of the aneurism is performed, the consequences will be the same as if the humeral artery had been wounded.

In all patients, then, whose vessels are distributed in the common way, without any considerable anastomosis between the humeral artery and its large branches in the fore-arm, it is in vain to expect that any pulse should be felt at the wrist immediately after the operation of the aneurism is performed; and, at the same time, the want of a pulse there needs not make the surgeon go on precipitately to the amputation of the member, because the numerous small anastomoses may be sufficient to keep life in it, and may possibly be gradually enlarged so much, as to restore
vigour

vigour and strength to it, and even to make a perceptible pulse at the wrist.

When the operation of the aneurism is performed at the bending of the elbow to one who has the anastomosis represented in fig. 4. the humeral artery must be tied, but the pulse at the interior side of the wrist will continue; and probably that on the exterior side will soon be restored, because the blood may have the short retrograde motion from the insertion of the anastomosing tube into the ulnar artery, to the place where the radial artery begins, without any great diminution of its momentum.

Those who happen to have such a division of the humeral artery as is represented in fig. 5. can only have the radial artery hurt in venæsection; and, after the operation of the aneurism, will have a stronger pulse than formerly in the interior side of the wrist, but will probably want it in the exterior side.

If the vessels anastomose as in fig. 6. you will readily see, that, the anterior branch only being hurt, the operation of the aneurism may be performed without interrupting entirely the course of the blood either in the radial or ulnar artery; and therefore the pulse may still be felt in the common place on both sides of the wrist.

I have very little to add, by way of remarks on the history related by Mr Macgill, having, in the account already given of the formation of aneurisms, prevented any explication of the principal phenomena. I may, however, observe, that in that history we can trace the gradual formation of the polypus; and, from the mixture of the deep-coloured parts of the blood then squeezed out, with some of the dissolved cellular membrane, may understand how a liquor, like to coffee made of half-burnt beans, could be collected within this aneurism.

If the common notion of the true aneurism being a sac formed by the dilated muscular coat of arteries, has not had its rise from theory only, I would suspect, that the first assertors of it, seeing the pleura covering an aneurism in the thorax, or the tendinous aponeurosis of the biceps here in the arm adhering firmly to such a tumour, mistook them for the muscular coat of the artery. I have an argument for this suspicion, which seems very strong to me, whatever it may do to others who are less liable to mistake one thing for another: it is this, That notwithstanding my
theory

theory and dissections had brought me to think true aneurisms to be at least a very uncommon disease; yet when I saw Mr Macgill lay the tendinous aponeurosis bare, I was ready to have renounced my opinion, being persuaded it was the muscular coat of the artery, till he most dexterously prosecuted the aponeurosis to its rise from the biceps, and so fully convinced me of the mistake into which I should most readily have been led, without discovering it, if the operation had been performed in the more speedy way of laying the whole tumour open by one incision.

CASE of an ANEURISM.

ANDREW RADY, living in Galloway, had the misfortune, in being bled in the basilic vein of the right arm by some gardener there, to have his artery hurt, which was followed by an aneurism. Some more than a year after, he came to town here, and was received into the Infirmary in May 1735. On the 22d day of that month, Mr George Cunningham, the surgeon then in attendance, performed the operation. After the tourniquet was applied, Mr Cunningham laid open the tumour from one end to the other, with one longitudinal incision; then taking out the polypous substance, and a small quantity of liquid blood, the small aperture of the artery was so plainly seen, that I put a probe into it, and raised the trunk of the artery, while he passed the needle behind it, the sides of the wound being held asunder in the mean time by two blunt hooks. The proper membrane of the tumour was very thick and strong, and required force to push the blunt aneurism-needle through it; but the nerve was pressed by the tumour a good way from the trunk of the artery, so that there was no danger of taking the nerve within the ligature. After making the superior ligature, the tourniquet was untwisted, but no blood came by the orifice; which shewed the anastomosing canals to be very small: the second ligature was, however, made below the orifice, for security. The cavity was filled with soft lint, and the other ordinary dressings were applied. That afternoon his hand swelled and became warm; which removed all our fears of the circulation being entirely stopped. No pulse was to be felt on either side of the wrist for several days; but before the 5th of June, when both the ligatures suppurated off, the pulse was plainly to be felt on both sides of the wrist; and he cured soon, having as much strength and motion in that whole member as ever.

To make this operation more speedy and safe, I would propose, that as soon as the longitudinal incision is made, and the polypus with the blood is removed, the patient's elbow being bended some way, the operator should take hold of the humeral artery with the thumb and forefinger of the left hand; and, gripping it towards the back-part, should push the needle close upon his own nails, by which he has a sure direction whereby he may shun the nerve, which he can readily distinguish from the artery by feeling, and can, in that posture of the arm, easily draw the artery so far outwards as to keep free of the nerve.

The operation then of the aneurism, which appeared, by the description surgeons gave of it, to be very nice, difficult, tedious, and precarious, may be done easily, quickly, and safely, by opening the whole tumour at once, and then putting the ligature about the artery as just now described.

A WHITE SWELLING of the KNEE.

MANY instances are daily seen of that tormenting, dangerous disease, the *white swelling* of the joints: but before one has an opportunity of examining them by dissection, to understand the nature of the disease right, the matter has become so sharp, that it erodes the bones themselves; and then one sees the same thing as he would do in a *spina ventosa*. I met with one patient in our Infirmary, whose joint of the knee was just as far advanced as I wished to examine, when it was amputated. It gave me a better idea of that disease than I had before, and possibly may do so to some others.

Isabel Blackadder, a young woman of a delicate tender constitution, having hurt her left leg by a fall some years ago, an ulcer broke out near her heel, and several pieces of bone cast out at it; but it recovered so well, that she went to service again.

In the end of 1734, having hurt the same leg by another fall, the knee swelled, and became very painful and stiff; for which she was taken into the Infirmary: where, after blooding, a few doses of *aquila alba*, and embrocation with *aq. Mindereri*, the swelling and pain both seemed to abate; but soon became as bad as formerly, and never afterwards yielded to any medicines.

The skin of the swelled parts was not discoloured, and on the inside of the joint a fluctuation was felt in one or two points; but the quantity of liquor appeared very small, and the fluctuation had a different feeling to what commonly pus collected in a cavity has. Her pains were very sharp, especially upon the least motion of the affected leg; her flesh and strength decayed daily, and the hectic symptoms increased: which at last brought her so low, that she could not be raised to a sitting posture with-

out fainting ; which laid her under the necessity of suffering the member to be amputated.

In this condition she was when the member was cut off above the knee by Mr Douglas ; after which she recovered daily, and walks on a wooden leg of the same form which Alexander Sheppard used (*a*).

When the diseased joint was dissected, all the cellular membranes, in which fat is naturally contained under the skin, between the muscles and tendons, and upon the ligaments, were found full of a glairy matter, which had insinuated itself so much every where, and had made the other parts so soft, that we could scarce distinguish one from another. In several places of this glairy substance, there were small cavities full of pus. When the articulation of the knee was opened, all the mucous glands and fatty membranes were seen in the same condition with the exterior parts ; the semilunar cartilages themselves between the tibia and femur being quite soft, and with the same cellular mucous appearance that the glands had. We also observed some pus within the cavity of the joint, but the extremities of the bones were scarce begun to be eroded.

(*a*) See No XIX. *infra*.

Part of the CARTILAGE of the JOINT of the K N E E separated and ossified.

IN the letter inclosed in this paper *, you have an account of a white swelling from a very uncommon cause, treated by my good friend Dr Simpson, professor of medicine in the university of St Andrew's. In it the Doctor does not, and indeed could not, determine how the loose bone he describes came into the cavity of the articulation. I believe it may not be disagreeable to you to relate what I saw once in the joint of the knee, very like to the bone he took out, and which may serve to explain that phenomenon.

In the body of a woman, aged 40, which I dissected in February 1726, I found, within the ligament of the articulation of the right knee, a bone of the shape and size of a small turkey-bean, depending by a ligament half an inch long from the external side of the tibia. The bone, when cut, had only a thin external firm plate, being composed within of cells which were full of oil. On separating the femur and tibia, I saw the ligament came out from the exterior edge of the cartilage covering the exterior cavity of the tibia; and more internally a part of the cartilage of the tibia, of the same shape with the bone, was wanting. In Plate II. fig. 7. A is the bone hanging by its ligament, and B is the bone cut open. The circumstances of this malefactor made it impossible for me to know exactly her symptoms or complaints before her execution.

* This, and the letter alluded to, make Art. xix. and xx. of Vol. IV. Edin. Med. Essays.

An anomalous TUMOUR of the LEG, unsuccessfully treated.

A WOMAN, about forty-six years of age, after having been troubled several months with a tumour on the outside of her leg, asked my advice. The external part of her leg was equally swelled: only about the middle it pointed, as we commonly call it, or was more prominent, red-coloured, and felt softer; and, on pressing it with the fingers alternately, a liquor fluctuated below them. The pains of this tumour were so violent, that the patient assured me they had not allowed her, for some time past, to sleep a quarter of an hour at once. Her body was very lean. She had no appetite, but a constant thirst. The hectic paroxysms and night-sweats came regularly every day. Every third day she was seized with a diarrhœa. Her menstrua had left her a considerable time before.

Imagining most of these symptoms to proceed from pus pent up and absorbed by the eroded vessels, I was of opinion they would probably abate, if that matter was freely evacuated by an external orifice. Having therefore applied suppurating cataplasms two days, and the teguments of that prominent part becoming thinner, with the fluctuation still more evident, I made an incision of an inch and half long with a lancet. In the cutting, I was sensible, by the resistance and grating sound at the edge of my lancet, that the tendinous aponeurosis was cut: though the incision was large and deep enough, not one drop of pus was discharged; only two or three ounces of mucus dropped out.

Next day I brought two surgeons in my neighbourhood to visit my patient; and, having taken off all the dressings except the pledgets which covered the orifice, I desired them to feel the swelling, and give me their opinion of it. They both affirmed their having felt the fluctuation of matter under their fingers. When the last pledgets were taken away, a fungus appeared at the orifice, which resembled the flabby *tunica cellulosa*, so often to be seen in the back and other depending parts of those that die

die of tedious lingering diseases. I cut off some of this fungus, put gentle escharotics on the remains of it, and dressed the rest of the wound with suppurants. On the second day, the fungus came out much larger, and violently stretched the aperture of the teguments and tendinous aponeurosis, by which a gangrene was begun all round the edges. I cut off the fungus, enlarged the orifice considerably, and dressed it up with antiseptics and suppurants in the common way. In two days, the gangrened parts fell off; and, the aperture being now very large, I dissected, from between the two bones of the leg, near a pound of that flabby substance. After having cut as deep as I durst, without risking the opening of the large arteries, I thrust a probe through that soft fatty substance, till I felt it and saw it striking against the skin of the opposite part of the leg.

Expecting therefore no success from this method, I resolved to perform the amputation as soon as the fever and diarrhœa, which were now come on, were abated; but neither were stopped by any medicines given, and in a few days the patient died.

The skin of all the leg appeared after death sound: but the *tunica cellulosa* and muscles were all degenerated into that pappy substance which had appeared as a fungus; and I could not distinguish one muscle from another, though I was at pains to dissect them.

The periosteum was every where separated from both tibia and fibula; between it and the bones, an acrid dark-brown liquor was contained; and the surfaces of the bones were rough and yellow.

I had occasion soon after to see a leg affected with just such another sort of tumour; but it was opened sooner, before any other bad symptoms had come on. It would not cure with either external or internal medicines, and the patient would not allow amputation; so that it was palliated, till both surgeon and patient wearied of each other.

Pray, Gentlemen, under what class of tumours is this to be reckoned? Is it a-kin to the windy swellings of the joints? or to what the French call the *fatty tumours*?

If you know the species of tumour, what is the pathognomic sign by which it is to be distinguished from *erysipelas-œdematodes*, or the slow phlegmons; for I am much afraid of falling into some such mistake as the former, unless you will explain the difference to me.

HISTORY of an ULCER of the LEG.

ALEXANDER SHEPPARD, a finith, aged 36 years, having accidentally wounded the fore-part of his leg with the point of a hook about the beginning of harvest 1732, an inflammation and suppuration were brought on this member, and were neglected till October, when he was received into the Infirmary here.

In examining the state of this diseased leg, a sinuous ulcer was discovered to extend itself the whole length of the leg. This, being laid open, sent out only a very small quantity of sanious ichor; and, in a few days after, the knee was attacked with a painful swelling, which soon yielded to a fomentation of urine, in which wormwood, chamomile, and mallows had been boiled. The ulcer seemed to be in a good way for some days after this: but then proud spongy flesh rose from it, which was kept down by sprinkling *red precipitate* upon it; and, in order to correct his bad habit of body, he was ordered to drink plentifully the decoction of guajac, and had repeated doses of mercurial purges given him. These medicines had a good effect for some time; but, upon interrupting the use of them a little, the matter of the ulcer turned more sanious, he felt a pain and stiffness in his knee, pimples broke out all round the ulcer of his leg, and the itch appeared every where else on his skin. The mercurial purgatives were therefore repeated, and again brought the leg to a better condition, but left a diarrhoea that continued several days.

In the beginning of January 1733, he was seized with a feverish paroxysm like that of an ague, and next day a red swelling of the erysipelatous kind was observed on the back-part of the diseased leg near the ankle.

The day following, the tumour of the leg was less; but his knee was considerably swelled, though without any heat or redness; his pulse was frequent, with thirst, heat, and other feverish symptoms. A low vegetable diet was prescribed, with emulsion, or milk and water, for his drink, and emollient fomentations and cataplasms were applied to his knee. Not-

withstanding which, the feverish symptoms continued, the knee swelled more and became more painful, and a large suppuration began in the back-part of his leg. These were soon followed by an obstinate diarrhœa; so that, before the end of this month (January), he was emaciated to skin and bone, was so weak as scarce to be able to turn himself in his bed, his appetite was quite lost, and he had constantly a quick pulse and thirst, with night-sweats, and a colliquative diarrhœa. His knee was greatly swelled, with its ligaments so weak that the bones could be made to have the appearance of a partial luxation, and a certain grating was felt on moving the patella from one side to the other; at the same time, a large collection of pus was made in the back-part of the leg.

He had refused to allow the amputation of his leg to be made when it was first proposed to him; but, finding himself worse every day, and being convinced that the only chance he had for life was to have that operation performed, he allowed it to be done, on the first day of February, by Mr Hope, who was the surgeon then attending.

The member was taken off four inches above the knee. When this joint was dissected, the cartilages were found eroded, and the bones were become carious.

From the day of the operation, he had no more diarrhœa; and, in twelve days after, all the other hectic symptoms were gone, his flesh and strength being evidently recovered considerably.

The cure went on successfully all the months of February and March; except that, on March 16th, a livid-coloured spot, about the size of a sixpence, was observed towards the posterior part of the wound, which, having a pledgit dipped in brandy applied to it, could not be seen next dressing.

April 6th, several granula of flesh that came out, with very small peduncles, from the solid substance of the bone, threw out a considerable quantity of blood; and four or five more such hæmorrhagies, from these fleshy papillæ, happened in this month, and were always stopped by applying oil of turpentine.

April 12th, a large livid fungus sprouted out from the cavity of the bone, and several other such fungi were seen upon the fleshy parts also
of

of the wound. These were removed by repeated searing with a red-hot iron, and the application of oil of turpentine.

In the beginning of May, he was altogether free from the fungi and hæmorrhagies; and, May 15th, a piece of the thigh-bone, about the thickness of a crown, exfoliated.

He was then cured of his itch; and appeared to be every way in good health and vigour, with the bone covered, and all the wound cicatrized, except about the breadth of half-a-crown in the middlemost prominent part where the bone was, on which a skin could not be brought; and therefore it was necessary to contrive such an instrument for him to walk with, as would not allow the weight of his body to bear on this raw part, and that could make the soft parts to support the body, without resting on the bone.

The instrument he made use of with success, was of the form which you see represented Plate II. fig. 8. 9.

A (fig. 8.) is a box of wood made firm on the outside by two rings of iron *a, a*, and covered within with a thick quilting of wool under chamois leather.

B is the stick or leg, of such a length as answers to the sound extremity.

A piece of strong bend-leather, shaped as in fig. 9. is fixed to the brim of the box A, the two ends CC being at a distance from each other, and having py-holes for passing the lace D (fig. 8.) through; the middle long part E has a large piece of thick chamois, or thin well-dressed buff-leather, F, fixed to it.

G, G, is a belt of buff, at one end of which is the buckle H, and the other end I is pierced with holes for easily passing the tongues of the buckle.

K, L, are two small straps coming from the lower edge of the belt G.

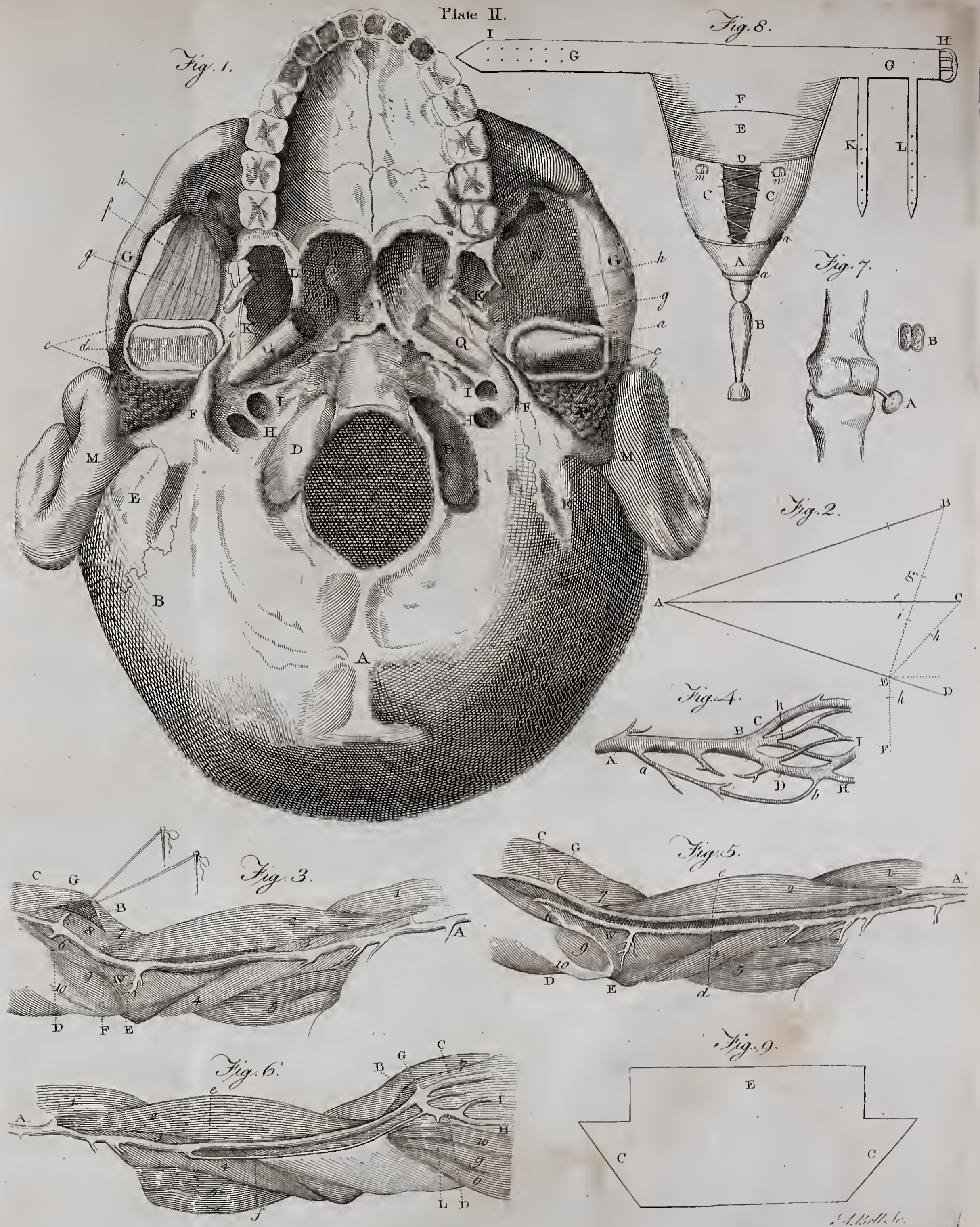
m, n, Are two small buckles fastened to the bend leather.

The patient having the thigh of his breeches fitted to his stump, so that the prominent raw part, with the dressings upon it, passes through a hole left in the end of the breeches, the stump is put through the bend-leather into the pyramidal box, which does not allow the raw part to sink to its bottom, and the laced part D is brought to answer to the course of the large crural vessels on the inside of the thigh. Then the lace is drawn so tight, that the bend-leather may gripe the thigh all round, by which the

whole weight will not rest upon the cicatrix of the stump on the sides of the box, but the teguments of the thigh all bear a share, while the tight lacing will have no bad effect in stopping the circulation, the larger vessels being free from any compression. E comes upon the outside of the thigh, as high as the great trochanter; and F covers the glutæi muscles, and, being pliable, allows them and the joint to move easily. The belt GG is then, fastened round the loins; and the straps K, L, are secured by the buckles *m*, *n*, to support the instrument in the inside of the thigh.

If the belt GG does not support all well enough, a suspensory must be put over the shoulders, to be fastened to it at two different parts both before and behind.

Any who read the preceding history, and consider the nature of the matter evacuated at the sinus, its small quantity, the feverish symptoms coming upon this, nature's effort to throw it off by a new suppuration, and by the skin where it erodes the conduits, it could not pass, and hæmorrhages, fungi, &c. that came on afterwards, will observe very strong marks of a sharp purulent matter reassumed into the blood; and, from the success of this case, surgeons may be encouraged to undertake operations to patients with very unfavourable symptoms, when they can thereby take away a *fomes purulentus*, or any other cause upon which the symptoms depend. That it may not be thought I recommend bold operations from the success of this single instance, I must tell you, that, among the small number which our Infirmary, so lately erected, can maintain, there are several such other cases recorded. 1. Patrick Higgins, fourteen years of age, with the bones of his leg carious, hectic fever, colliquative sweats, and diarrhœa, was received into the Infirmary, September 17. 1730, where his leg was amputated, and went out of it plump and strong, with a firm cicatrice, 21st December thereafter. 2. Margaret Cleghorn, hectic, weak, and emaciated, with the bones of the foot and leg carious, was admitted 2d March 1732, underwent the same operation, and was perfectly cured. 3. Isabel Blackadder, whose history I have already related. And, analogous to these cases, I have seen people in much the same circumstances from very large ulcerated bleeding cancers, large internal abscesses of the liver, kidney, &c. who recovered daily after the amputation of the cancer, or opening the abscesses.



R E M A R K S

ON THE
AMPUTATIONS of the larger EXTREMITIES.

IN the operations of surgery, there are a number of little circumstances, several of which seem at first view to be of no great consequence; but, when their observation or neglect comes to be attended to in practice, they are found to contribute considerably to a speedy or tedious cure, to bring on or prevent bad symptoms, to keep the patient easy, and preserve him, or to put him to pain, and bring him into danger: and therefore their good or bad effects ought to be duly considered, and the proper caution concerning them ought to be given, by those who write for the public upon such subjects; in which particular our chirurgical authors are for most part very negligent. As an example of this, I shall make some remarks on the amputations of the larger extremities; an operation, than which there is none of those that are called the greater or more dangerous, more frequently performed, and about which the directions seem to be very particular, and confirmed by the frequently repeated experience of authors.

This operation of amputation consists in a proper precaution to prevent any hæmorrhage during the operation; cutting all the soft parts, which cover the bone or bones; sawing it or them through; securing the cut vessels from bleeding afterwards; and dressing, so as to promote a safe and easy cure. In this order, then, I shall make my remarks.

The precaution taken to prevent a hæmorrhage during the operation, is by applying Petit's, or the common tourniquet. I shall refer to what the contriver Mr Petit says (a) of the advantages and conveniences of his instrument;

(a) *Memoires de l'Acad. des Sciences*, 1718.

strument; and shall only consider the common one, which surgeons, who generally have not, or do not know the other, do commonly make use of. It consists of a thick substance, to be placed on the large common artery of the member, for compressing it; a circular compress to be put round the limb, to defend the teguments; a strong strap that is to be twisted; a small stick with which the twisting of the strap is to be made; and a small piece of pasteboard or horn, to allow the twisting to be made more easily, and to defend the teguments below the twisted part from being hurt by it.

Several French authors order a thick compress to be placed over the artery for its compression: but a roller, which our surgeons generally use, is much preferable; because, as the arteries lie deep in the interstices of muscles, between which the compressing substance must sink before it can affect the arteries, this cannot be done near so well by the plain surface of a compress, as by a convex roller.

The size of this roller must be proportioned to the distance between the muscles, and to the depth of the situation of the artery. If the roller is too thick, it will be borne off from the artery by the muscles; and if it is too small, the muscles will hinder the twisted ligature from pressing it sufficiently on the artery.

Not only must the size of the roller be regarded, but care must be taken to roll it up of a due firmness: If it is too soft, it will have the fault mentioned of the compress; if it is too hard, it presses with too narrow a surface, from below which the artery may slide, and the circulation may therefore be continued in it after the ligature or strap is fully twisted. One must easily judge that such a firmness is required in the roller as allows it to retain its cylindrical form, till a considerable force is applied to make it a little flat.

Authors in their writings, and surgeons in performing this operation, are uncertain in the application of the circular compress of the tourniquet. Some put this compress round the member, before they place the roller on the artery; which may be attended with very bad consequences: for, if it be wrapped loosely round, it comes to be wrinkled and doubled by the twisted strap, which both hurts the skin, and hinders the twisting; if it be put tight round, it keeps off the roller from sinking between

between the muscles, and the hæmorrhage is not prevented, as I have seen happen both from this cause and too hard a roller. The roller ought therefore always to be applied first upon the artery, and then the circular compress is to be drawn tight over both roller and member.

If the roller and compress are not sewed to each other, the roller may sometimes be in hazard of shuffling out from below the compress in the time of the operation, and for most part will do it when the twisting strap is left loose after the operation, and all the dressings are applied, which may be attended with danger of hæmorrhage during the operation, and the surgeon is disappointed of using the tourniquet so quickly as he would wish, if any bleeding happens after the operation. Not only therefore ought the roller and compress to be sewed together, but the ends of the compress ought to be so secured that it may not fall off.

I have nothing to remark on the common directions for the strap, pasteboard, twisting-stick, and the twisting, unless to take care that the strap is strong enough, and no way worn, lest it break, and the vessels be let loose upon the operator in the middle of the operation. If such an accident should happen, the surgeon had need to keep his presence of mind; which if he does, there will be no great danger: for an assistant may supply the want of the tourniquet, by griping the roller firmly, till either a new strap is provided, or rather till the surgeon has finished the operation; which it is his business to do, in such circumstances, as quickly as he can. Nay, though there is no such assistant, the surgeon, by sawing the bones through very quickly, and then putting his fingers on the large arteries, till he has brought the stitches round them with the other hand, may prevent too great a loss of blood.

In cutting the soft parts which cover the bones, all care should be taken to have the skin and bone as equal with the surface of the wound in the muscles as possible; for, if the skin is retracted much in the circumference of the wound, and the bone jets out far in the middle, a tedious cure is to be expected. For this purpose, the skin is not only to be drawn firmly up, while the fillet, which is put immediately above where the circular incision is to be made, is applied tightly, but the assistant who holds the upper extremity of the member, is to draw the skin, and, if he can, the muscles too, as tightly as possible, both to save them, and

to keep them tense, by which they cut much more easily. And the operator is not only previously to cut the skin round, and then to make the circular incision of the muscles close by its upper cut edge in the thigh, and other places where a strong retraction of the soft part is expected, as is recommended by some late French writers; but, after cutting the periosteum round as near to the flesh as possible, he is to scrape it upwards with the edge of his knife, by which the side of the blade must push upwards the muscles which are next to the bone, and which retract least because of their connection to the bone; so that, the bone being sawed near to the flesh, the whole surface of the stump may be plain, without any pyramidal prominence in the middle, which not only protracts the cure by its larger surface and distance of the skin from the bone, but is a great inconvenience to the patient ever after by the prominence being perpetually galled with every thing that presses on it.

Before the saw is to be applied, a piece of slit linen is always ordered to be put round the bone, wherewith the soft parts may be drawn up and defended from the teeth of the saw. I have almost always seen one of two inconveniences happen from this piece of linen: Either the surgeon applied his saw so close to it, that the linen was engaged in the teeth of the saw, which made it impracticable for the surgeon to go on in sawing, till it was disengaged; or else, to shun this, he left too much of the bone without the flesh, with a greater chance of a tedious exfoliation, and a certainty of a pyramidal stump. This linen ought either not to be applied, from the want of which I never saw any inconvenience; or it ought not to be allowed to touch the bone, that the surgeon may be at liberty to apply his saw upon the bone close enough to the flesh.

The common directions are sufficient for the sawing.

To secure the cut vessels from bleeding, astringents and other styptics are found altogether insufficient in such amputations as I now treat of. Caustics are both uncertain, and destroy more than is necessary. Compression by common bandages cannot restrain the hæmorrhage; and Mr Petit's new compressing machine (*a*), if it is to be depended on to stop the bleeding of arteries in the muscular part of the thigh at a distance from any bone, or if it can be applied to that artery of the leg which
lies

(*a*) Memoires de l'Acad. des Sciences, 1731.

lies close to the side of the fibula where it pierces through the ligament between the bones, will be long before it is in the possession of most surgeons. The artery-forceps is generally neglected now as an inconvenient instrument, with which a surgeon may tear the artery, or may make a ligature which is too easily pushed off the ends of the vessels. Stitching with a needle and thread has been found by numberless trials to be such a safe and sure method of stopping the bleeding of large arteries, that it is now universally practised among us, and therefore is what I shall only here consider.

The form of the needles employed here, and the way of making a thin flat ribband, by waxing a number of small threads together for tying the vessels, instead of the common round threads formerly used, are now too well known to be insisted on.

In pushing the needle round the artery, the surgeon should be careful to carry it within the substance he pierces, two thirds or three fourths of the circumference of the artery: for, if the thread is only lodged within the flesh of one half or less of that circumference, the artery may be missed altogether in drawing the ligature, or such a small part of one side of the extremity of the artery may be taken into the noose of the knot, that it will easily slide off; and though the bleeding appears sufficiently guarded against at first, yet a fresh hæmorrhage begins soon after. I remember once to have seen this accident occasioned in the manner now described.

In passing the needle thus, as few muscular fibres, tendons, or ligaments, ought to be taken within the noose as possible, but the surgeon should attempt to thrust his needle only through the cellular substance in which the arteries of the extremities lie: for the threads, when drawn, have greater effect in bringing the sides of the artery together, when the substance comprehended in the noose is soft and thin, than when it is firm and thick; less pain is given by shunning the nervous parts; less substance is lost when the tied parts fall off; and there is no such danger of the stitches being so long in casting off, and consequently of the new flesh growing over the knots so far, that they are scarce to be come at to cut them away, without danger of opening the artery again; or by leaving the stitches, sinuous ulcers are formed in the stump, and no cure can be made. I have

more than once seen all those inconveniencies, from more than was necessary being taken into the noose of the thread in stitching arteries. This, which I look on as a hurtful practice, has some reasons to support it, which has brought people into the exercise of it; such is the fear they have of the thread's cutting the coats of the artery in tying, unless some other firm substance is taken in. But this none who makes use of such flat thread as I mentioned, and has been the least accustomed to make such ligatures, is in any danger of; nay, it is not in any one's power to cut the coats of an artery with such thread, by the sole force of tying: indeed, by pulling outwards at the same time he makes the ligature, the surgeon may tear the artery; but this every surgeon guards against. Next it may be said, in defence of comprehending the firmer surrounding parts within the noose, that otherwise the ligature may be pushed by the force of the blood over the extremity of the artery: But this will be found to be without foundation too; for, as soon as the ligature is made, the cellular substance beyond the stitch, having still a communication with the surrounding cells, swells, and turns firmer and harder, so as to prevent the thread from sliding.

That fear of cutting the coats of arteries in tying the threads makes surgeons frequently tie them too loose; if the blood is stopped, they require no more. But they ought to consider, that threads tying arteries only come away afterwards by the tied parts mortifying or suppurating away, and that the sooner such corruption is brought on (which will be exactly in proportion to the tightness of the ligatures) the separation of the threads will be the more speedy. The rule therefore will be, that, where the artery is very large, and consequently where the plug of coagulated blood obstructing its orifice, the firm concretion of its sides, the new sprouting flesh, or whatever else it is that blocks up its orifice, must be longer in forming, the ligature is not to be so very tight, that its separation may be longer in making, and all hazard of hæmorrhage may be shunned. But, where the artery is not large, the tighter the threads are drawn, so much the better, that they may sooner fall off, and the cure may be more speedy.

It may be easily judged, from what has been said that the compress of linen recommended by some authors to be put between one side of the
artery

artery and the noose of the thread, cannot be approved ; the effects of it being to prevent the tight enough ligature of the vessel ; and if it should shuffe out soon, an hæmorrhage must be expected ; or, if it remains, the pus which it imbibes will become too acrid.

After the two knots are made on the ligatures of the vessels, several writers recommend the thread's being left of such a length, as to turn over on the side of the stump ; but, when this is done, the blood or matter which comes from the wound never fails to glue those threads so firmly to the other dressings, that these can scarce be brought off without the threads being pulled more or less, which endangers the tearing the extremities of the arteries, or making the threads slide over them, to occasion an hæmorrhage ; whereas, by leaving the threads so short that they can scarce reach to the edge of the wound, they are always kept moist, and so cannot adhere to the dressings, to run that risk.

In amputations, the surgeon ought not to content himself with tying only such vessels as he observes throwing out blood, while the patient is faint with the pain, but he should endeavour to rouse him from that faintish state by a cordial ; and then, wiping off the coagulated blood with a sponge wet in warm water, he should examine narrowly all the surface of the stump, to discover the bubbling streams, to secure them before the dressings are put on, otherwise he may expect to be obliged, by a fresh hæmorrhage, to undo all.

At first dressing, surgeons use to be very anxious about the bleeding ; and, for that reason, applied great quantities of astringent powders : but these were observed to purse up the small vessels too much, and thereby to retard the suppuration ; while, by the hard cake which they form, they gall the wound, and cannot be taken off without much difficulty and pain ; and therefore they have been long disused in this country. In place of which, pledgits wet with hot oil of turpentine were applied : This gave very sharp pain ; and by it sometimes there is hazard of bringing on an hæmorrhage at its first application ; afterwards it hardens the vessels and resists the suppuration, and never misses to scald and blister the skin round the stump ; and thus creates such pain as the patient complains more of than he does of the wound. If the larger vessels be well tied, and no fault committed in applying the other dressings, there is

occasion for no other application to the wound than the threads of soft half-worn linen, which the French call *charpie*, the English *lint*, and we *caddis*; which is a gentle absorbent, is soft and easy to the wound, and, by the corrupting liquors it imbibes, proves one of the strongest, most mild and safe suppuratives.

Great pains were commonly taken to form the lint into neat pledgits before it was applied; but it is impossible to make pledgits without folding the extremities of the threads, where it becomes thicker and harder, and so makes an unequal pressure, which produces several ill effects. I have often seen wounds changed to the worse, by the unequal compression of pledgits, compresses, and bandages, of one dressing. In order to shun these inconveniencies, the lint needs only to be laid into thin parcels, as is done when pledgits are to be made; or rather the stump is to be covered with pieces of the new-invented scraped cottony lint in sheets, cut of a proper shape and size; for with these the inequalities between bones or elsewhere can be perfectly well filled up, and an equal soft compression can be made on the whole surface of any broad wound or ulcer; in all which the lint ought always to be applied in the form just now mentioned.

This way of dressing makes the compresses that are commonly desired to be put on the extremities of the arteries, and the particular pledgits for the bones, altogether unnecessary.

The bladder, which some yet recommend to be put upon the lint, is of no use, and only hinders the surgeon from discovering soon enough any oozing of blood from the stump, and therefore ought not to be applied.

The Malta compress is pretty well contrived, though it would be better to have a cap of woollen, or some such substance, that would contain the stump, without any part being doubled or folding over another, as must be done with the angles of the Malta compress, which therefore make an unequal pressure on the parts of the skin they are applied to. The two long compresses that are ordered to be applied cross the stump upon the Malta, seem unnecessary, if not hurtful; for being made to cross on the middlemost prominent part of the dressing, they press only the bone, which answers no purpose, and they hinder the equal compression which ought to be made by the bandage on the other parts of the wound. At
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the same time, the ends of these compresses which are laid upwards on the member, bruise and gall the skin when the bandage is applied tight upon them. I have seen them sink their whole thickness into the skin.

The circular compress commonly placed round the edge of the stump, with its ends folded over each other, is also of no service, and contributes to the unequal compression of the parts on which it is applied. The thick narrow compress ordered to be put on the course of the large artery of the member, and the turns of the bandage directed to be made round the limb, both which are said to be intended to moderate the course of the blood in the artery, and thereby to prevent an hæmorrhage, are effectual means of bringing the hæmorrhage, because they have much greater effect in stopping the blood returning in the veins, than they can have in preventing the flow of it through the arteries: on which account, all the arterious canals corresponding to these compressed veins, must be distended; and, among the rest, the cut vessels of the stump must be greatly enlarged.

Notwithstanding all the effectual methods we now have for preventing an hæmorrhage in amputations, surgeons still continue to act as if they were as much afraid of it as they had reason before either tourniquet or stitching were known, and by this do several hurtful things; among the rest, the too tight application of the bandage upon the other dressings is one. If the circulation is not entirely stopped, and a mortification brought on by it, they think it cannot be too tight. But besides this hazard of mortification, there are several disadvantages which they are exposed to by this practice; whereof the very thing they are afraid of, the hæmorrhage, is one, as I shall endeavour to demonstrate, in considering the effects of the different turns of the amputation-bandage applied tightly.

The longitudinal turns of the bandage, which are made to pass over the middle of the stump in different directions, to cover it all over, exert their greatest power against that middle part where the bone is, which bears over their pressure from the other parts, and the large arteries which shrink up farther than the extremity of the bone cannot be affected by their pressure. If this middle part is shunned in making the longitudinal turns, the flesh only is pressed; and therefore will be thrust up-
wards

wards from the bone, which is left prominent and bare, to occasion a tedious cure, and at last a pyramidal stump, which is always after uneasy to the patient. The immediate effect of too great pressure on the soft parts, is to hinder the small vessels from discharging themselves; which creates pain and inflammation, and does not allow the suppuration to come on. I had occasion to see this prettily confirmed in the case of one James Spence, who had the amputation performed in the middle of the fore-arm in the Infirmary here. By changing the posture of the fore-arm soon after the operation, he had made the longitudinal turns, which went also round the elbow, tighter than they were at first applied. Three days after, there was not the least appearance of ichor coming through the dressings, nor any suppurating smell; his pulse became quick; and he complained of pain, throbbing, and girding in the stump. I judged what was the cause, and cut all the longitudinal turns at the elbow: in a few hours after, his complaints were all gone, and the exterior dressings were stained with the liquor oozing through them; next day all the symptoms of a mild plentiful suppuration were seen, and the cure was soon completed.

The circular turns of the bandage, when tight, must stop the return of the blood in the cutaneous veins; and, by making thus a greater resistance to the blood in the arteries which anastomose with them, will occasion the contracting power of the heart and arteries to dilate, and force more blood into their other branches; but these being cut in the amputation, will pour out their blood, and so an hæmorrhage is brought on. Analogous to this it is, that when a ligature is put round the arm or leg, it becomes all red below, the lateral branches having much more blood thrown then into them than they had when the circulation was free. It can be to this cause only, that a phænomenon, which surprises many surgeons, is owing: to wit, after dressing a wound according to art, it bleeds; upon taking off all the dressings, not a drop comes out. If the surgeon wisely thinks to prevent any further bleeding, by still a tighter bandage, the hæmorrhage is greater, unless he will choose to risk a mortification. To satisfy some gentlemen fully of the truth I argue for, I took the management of a tourniquet while the amputation of a thigh was performing: after the large arteries were all stitched, I let loose the tourniquet,

quet, and scarce any drops of blood fell from the stump. I then gradually twisted the tourniquet; whenever it became a little tight, the whole surface of the wound seemed oozing orifices of vessels. I twisted it again fully, and stopped them all; then untwisting gradually, showed them the same bubbling scene, till the tourniquet was quite loose, when no more blood came.

From the whole, I would conclude, that no more is required of the bandage than to press the other dressings very gently to the wound. If a surgeon is to fall into any of the extremes, of too loose or too tight bandage, the former will, in my opinion, do much less harm than the latter.

Our British surgeons would do well not to be so free in blood-letting as the French operators direct. I shall not now examine whether the French constitutions require this evacuation more than we do; or whether so frequent and plentiful evacuations of blood is a faulty practice among them, introduced at first by a mistaken theory, and prevailing afterwards by custom: but this is certain, that though bleeding is exceedingly necessary in plethoric habits that undergo the amputation, and is the grand remedy when fever and inflammation seize a patient after this operation, it is by no means a general rule, that all who suffer amputation should be let blood of either before or after the operation; for I have in many instances seen the cure performed without one bad accident, when the patient has scarce lost two ounces of blood in the operation, and was neither bled before nor after it; and, on the contrary, I have observed, in the hospitals at Paris and elsewhere, people sink under the loss of blood, dying with œdematous swellings in several parts.

What I find had induced practisers to imagine, that in amputations there was a greater necessity of letting blood than in other wounds of equal extent with the stump, is their supposing, that, immediately upon a limb's being taken off, the remaining arteries of the body are obliged to circulate the quantity of blood they contained before, with the addition of what was sent to the amputated member; which additional quantity they pretend to relieve them of by venæsection: but when it is considered that the amputated member takes away its proportion of the liquors of the body with it, and therefore leaves no more in the other vessels.

fels than they contained before, the reason for this practice must cease. For some days after the operation, the patient is always kept on a spare low diet, to prevent any fulness; and consequently there is no occasion for bleeding in the first days after an amputation, on account only of any plethora the loss of a limb can be supposed to bring on. Afterwards, indeed, when the patient comes to recover his appetite, and a fuller diet is allowed, it is reasonable to think a plethora may be brought on by the chylopoietic viscera preparing a great quantity of chyle to be mixed with the blood, whose vessels will be too much crowded, because of the want of those that have been cut off. For which reason, it is necessary for all who have lost a large member, after their recovery, to use a spare diet, or to make frequent evacuations, otherwise they will probably be subject to the plethoric diseases.

The cases, then, in which blood-letting is required after amputation, are, when the patient is of a full habit of body, and has lost little blood before or in the time of the operation; or when there is violent pain or swelling in the member, without being occasioned by any application made to the stump; or when the pulse becomes very quick and strong, with heat, thirst, and other feverish symptoms; then indeed blood-letting, suited in quantity and repetition to the symptoms and strength of the patient, is absolutely necessary. But if, in the first three or four days after the operation, the pulse is only a little more frequent than ordinary, without violent pain or other bad symptom, a low diet, with cooling drinks and laxative clysters, if the patient is costive, will be sufficient.

It may perhaps seem surprising, that I have not mentioned hæmorrhage as one of the symptoms which require venæsection, the remedy universally employed for checking or stopping hæmorrhagies. My reason for this omission, is the opinion I have, that hæmorrhage, after amputation, seldom requires blood-letting; nay, that the common practice is pernicious in most such cases.—Vigorous plethoric patients have hæmorrhage, either from neglecting to tie some of the large vessels, for which ligature is proper; or from too tight bandage, which must be taken away or cut; or from fever, for which I have directed blood-letting: but by far the greater number of those who undergo amputation of the larger extremities are weak, emaciated, and more or less hectic from tumours or ulcers
of

of long continuance. These persons vessels are so lax, and their blood is so thin, that their stumps often bleed, during the time of the cure, from a number of imperceptible orifices. Venæsection exhausts the small remains of blood and strength of such patients, and increases both causes of the hæmorrhage. To such, therefore, I order *pulv. cort. Peruvian.* with *pulv. styptic.* several times a-day, claret warmed with cinnamon, mace, or nutmeg, as a cordial to be taken frequently; and I cause these spices and wine to be mixed with their food. The records of the Infirmary contain several histories of poor patients who were brought from the brink of the grave by this method.

The physicians and surgeons of the Royal Infirmary here have always followed the method above-mentioned, and have not lost one patient of fourteen who have had amputations of the larger extremities performed.

Since these fourteen, there have been eighty-five more patients in the Infirmary, who had the like operations performed on them, of whom eight died. Two of these eight had violent contusions on their bodies, and the limbs had a mortification in them. The other six were all emaciated with hectic symptoms before the operation, and survived it several weeks or months; so that the death of none of them can reasonably be imputed to the operation.

It is generally too soon to take off the first dressings on the second, third, or even fourth day after an amputation; for they still adhere to the wound, and cannot be brought away without pain and bleeding: And there being no such effectual suppurative as the liquor sent out from the wound, the fifth, sixth, or seventh day, is generally soon enough for removing the dressings. If the smell of the ichor of the wound becomes in the mean time very strong and offensive to the patient, it may be necessary to cut the band, and, with the assistance of scissors, to take off the compresses and exterior part of the lint, on the third or fourth day, and to apply clean things in their place; but the lint next to the wound ought not to be removed till the suppuration moistens and separates it.

At the second dressing, there is no occasion for any other suppurant, than not to be too anxious in cleaning off the pus that adheres to the stump, all moisture upon the skin being carefully dried, to prevent excoriation.

Nothing contributes afterwards more to a speedy cure than dressing seldom: The rule that might be taken from nature is, to wait till the patient is sensible of an uneasy itching in the wound; which shews the pus is beginning to turn acrid, which commonly happens every second or third day. And as I hinted formerly, an equal gentle compression is of great use in keeping up a right suppuration, and preventing the growth of spongy flesh.

If the threads with which the arteries were tied should remain too long, (that is, three weeks or a month, according to the largeness of the artery), and the new sprouting flesh covers the ligatures, they had best be cut out, lest, by the growing of the flesh, they should become so much covered that they can scarce be come at, and sinuous ulcers should be formed to prevent a cure. The best method of making this excision is, to take hold of the depending threads, and to introduce a probe or small directory along them, till it enters the noose; which is easily known by drawing the noose very cautiously outwards with them, for the resistance which the thread makes will very plainly be felt. Upon the probe or directory, slide in one blade of a pair of scissars a little opened, till the point of it is where the other instrument was, and the point of the other blade is consequently on the outside of the noose when it is sniped in two, and is easily drawn out. In bringing the threads away in this cautious manner, there is no danger of bringing on an hæmorrhage from the artery round which the thread had been tied; for long before this time, so much of what was taken at first into the noose must have fallen off, to make it quite loose, and without any effect upon the artery.

If the patient is of a tolerable habit of body, and is managed in the manner above described, dry lint, and sometimes touching the sprouting flesh with lunar caustic, are all the medicines necessary towards a complete cure, without any exfoliation of the bone; which the surgeon ought to be so far from endeavouring to promote, unless he sees the bone corrupted by some accident or mismanagement, that, on the contrary, it should be his study how to prevent it. The common methods for which, as also for procuring an exfoliation, are, in my opinion, very faulty. Of the fourteen who suffered amputation in the Infirmary, there was no exfoliation from any of their bones, except from the thigh-bone of Alexander Sheppard

Sheppard (a). In two others, Isabel Blackader and John M'Millan, who had the amputation also performed above the knee, towards the end of their cure there was a very small piece or two of bone observed among the pus: but in no other was there any thing like bone seen to come off, though in some of them it was thought altogether improbable to prevent some corruption and consequent separation of a part of the bone; particularly in Margaret Cleghorn, whose tibia and fibula were so spongy at the place of amputation below the knee, that, had their condition been known before, the knife might have been made to cut them through as well as the teguments and muscles. Notwithstanding which, and a bad hectic habit of body, both bones were quite covered with flesh at the third or fourth dressing, the wound healed soon, and the cicatrice has remained now firm several years.

In these remarks on amputations, I have blended the rules of management so with reasoning, that several readers will not at first have a full orderly view of all the steps to be taken in performing this operation after the manner I have proposed; nor do I design to sum up the agenda, on purpose that those who have most need of rules, I mean the young surgeons, may have them more firmly fixed in their memories, by taking the trouble to compare what they read in the books of chirurgical operations with what has been said here, and then to form for themselves a complete description of the whole operation and method of cure, by following the order I have done, but supplying from their books what is here superficially passed over as being common, and changing the ordinary directions for such of mine as they shall think reasonable and confirmed by practice.

(a) See No 19. *supra*.

N^o 21.

H I S T O R I E S

O F

COLLECTIONS of Bloody LYMPH in Cancerous BREASTS.

NO mention being generally made by chirurgical writers of a collection of bloody lymph in the breasts of women, as a consequence or attendant of the scirrhus or cancerous tumours of those glandular parts, the following histories of such cases may at least teach practisers to know when they meet with such a disease, and may save them from being accused of destroying their patients by their ignorance.

I. A woman about fifty years of age showed me her right breast, in the exterior side of which there was a large very hard unequal tumour, in which she frequently felt a sharp pain. In the hollow of the arm-pit was such another hard tumour. Both of them had increased very slowly.

I ordered her to be let blood of, to take a cooling purgative ptisan once a-week, and to live on a spare cooling diet, which soon made the pains easier. Some people, however, having promised to make a complete cure of her breast, prevailed on her to apply warm suppurative cataplasms to the part; which brought a fluctuation of liquor that was believed to be a complete suppuration, till it broke, when, as the woman and her relations informed me, about four pounds of bloody water ran out: After which the woman was in constant violent racking pain, which made her again desire me to visit her. Near the arm-pit, there was then an orifice which could admit three fingers at once, that was the entry to a very large hollow ulcer, from which there was a constant discharge of abominably stinking watery sanies. Upon pressing the sac, I made several
spoonfuls

spoonfuls of this liquor to run out. The woman was so weak that she could not turn herself in her bed, to which she was confined; her pulse was very quick and low; she had a diarrhœa, night-sweats, and cough; and was kept constantly awake by the sharp pains of the fore.

To make her somewhat easier the short time she had to live, I made tepid rose-water, with a little vinegar, brandy, and liquid laudanum, to be injected into the sac frequently; and gave her a cordial julep, with some laudanum to be taken sometimes: By which the pain was blunted during the two days more she lived.

II. My advice was asked for a middle-aged woman living in the country, who had been two years sensible of a hard tumour in the upper part of her left breast, which was very small in the beginning, but was increased gradually to a great bulk, notwithstanding different medicines she had taken, and the application of mercurial and gummous plasters, &c. The cutaneous veins of this breast were turgid; the skin was become red; lancinating pains often pierced through the tumour, which was very hard. At the time of the menstrual evacuation, the tumour became so large as to appear to be fixed to the ribs, upon plentiful blood-letting subsided, and was again moveable.

My opinion was, that either the breast should be extirpated: or, if that was not consented to, by general evacuations and a low diet, the increase of the tumour should be retarded; and by a cooling lotion, such as *acet. lethargyr.* diluted with water, the inflammation of the skin should be prevented.

Some time after, my correspondent wrote to me, that the tumour had suddenly increased to a very great bulk, with an increase of the pain: that it then became soft in some parts, with a fluctuation of liquor, while the hard tubercles were felt at other parts: that at length the whole tumour became red, soft, and full of liquor; and had been opened at the lower part, when two pounds of a bloody water, which had no smell, were evacuated.

Next day the pain was much more violent than formerly; the wound had a cadaverous smell; and the superior part of the breast was still turgid with liquor: To evacuate which, another incision was made; and, four pounds of the bloody water being let out, the breast became very flaccid,

flaccid, the pain increased violently, a gangrene appeared on all the skin of the breast, and next morning their patient died.

When the breast was dissected afterwards, it was found to be an empty bag without any tumefied gland in it.

III. A middle-aged woman, mother of several children, who had always been of a weak habit, and subject to nervous disorders, having accidentally bruised her right breast slightly, felt soon after a hard tubercle toward the exterior side of that breast, which, notwithstanding some purgatives and aperient decoctions that were given to her, increased considerably. She was with child when I first saw her along with several other gentlemen, who thought the extirpation proper: But her condition prevented its then being performed; and gentle deobstruents, with mild food, were recommended.

The tumour grew bigger, a small hard knot formed below the edge of the pectoral muscle, and the axillary glands tumefied and became hard.

She aborted in the sixth month of her pregnancy; and had a very plentiful discharge of lochia, but without any change being made on the tumours. As soon as she had recovered from the abortion, she took rhubarb and other mild purgatives frequently; her menses returned in sufficient quantity at the regular periods; she was more free of the nervous disorders than she had been for a considerable time; the tumours however in her breast and arm-pit increased fast.

After the whole breast seemed to be scirrhus, a fluctuation of liquor was perceived in several places toward the exterior and superior part of the tumour, and she complained of pricking pains in it. Soon after, the breast swelled fast, the fluctuation was felt every where in it, and the veins of the skin became very large and varicous, the uneasiness from the weight and pain keeping the patient almost entirely from sleep.

The teguments at last turning red, pointing, and so thin that they would soon have been opened by the liquor, a very small lancet was pushed into a depending part of it free from large veins, and three pounds of a blackish red lymph were allowed to run out; and the further evacuation at that time was prevented by a tent adapted to the small orifice, secured by a piece of adhesive plaster.

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The liquor which was drawn off had no smell; and, when exposed to heat, coagulated as the serum of the blood does.

The patient bore the evacuation well, and was easier than ordinary all day.

Next morning, when the dressings were removed, the skin appeared of a natural colour, and the veins were all contracted. A pound of the same sort of bloody lymph flowed out of the wound. After which the glandular part in the middle of that breast could be distinctly felt, and did not seem larger than the glandular part of the other breast; but the tubercle at the edge of the pectoral muscle, and the hardened axillary glands, were as large as ever.

After the second dressing, the patient complained of a sharp pain near to the wound; which being suspected to be occasioned by the point of the tent touching some of the glandular parts, now when the breast was collapsed, it was changed for one no longer than would go no deeper than the thickness of the lips of the wound.

Betwixt this third and the fourth dressing, the lymph oozed at the sides of the tent, and had somewhat of a putrid smell.

On the fourth day after the opening, the teguments were so thin as to allow the original tumour in the exterior part of the breast to be distinctly felt; and it seemed rather larger than when it began to be concealed by the collection of lymph.

On the fifth and sixth day, there was little change; only the lymph became more foetid, and more of an ashy colour.

Seventh, the large tumour of the breast felt softer.

Eighth, the quantity of lymph was less, and some tolerably good pus came out upon the tent. The smell and constant oozing of the lymph being uneasy to the patient, a sponge dipt in *aq. calc.* and *aq. Regin. Hungar.* and afterwards pressed near dry, was laid over the breast.

During the eleven following days the appearances mended; for the quantity of liquor flowing by the orifice decreased, its smell became less foetid, and its consistence was nearer to that of pus; at the same time the large tumour became less and softer.

Afterwards frequent suppurations came on in different parts of the teguments: The glandular tumour increasing, the pain deprived the patient

tient of sleep, and, with the evacuation, wasted her, took away her appetite, and made her gradually weaker; so that, after suffering, for two months more, all the uneasiness which commonly attends ulcerated cancers, she died.

IV. A woman who had born several children, being again with child in 1733, the 37th. of her age, observed the nipple of her right breast drawn inwards, so that, when she was brought to bed, the child could not catch hold of it to suck it.

When this child was a year old, the mother was suddenly frightened when her menses were on her; which put them away, and she never after had any return of them.

In March 1739, she recovered from a dangerous fever; soon after which, she was exposed to cold, and was violently in wrath, fear, and grief, receiving at the same time a bruise on her right breast. This shock confined her to her bed three months; and soon after it, she perceived a small painful red tumour in the inferior exterior part of the right breast, which she neglected.

In the end of July 1740, when I saw her first, the right breast was very large and hard, with such sharp pain that she slept none; the veins of the skin were varicous, and the nipple was shrunk out of sight: I however felt a fluctuation in it, and judged it to be such a case as the preceding.

Next day, July 31st, I made a young gentleman, my pupil, put a small lancet in the inferior anterior part, where it was thinnest and most prominent. He let out eight ounces of a bloody lymph, without smell, but salt when tasted; which, held in a spoon over a candle, coagulated. A very short tent was put into the orifice, secured from going into the cavity by a thread, and hindered from coming out by an adhesive plaster. She slept better that night, having less pain.

August 1st, Four ounces of the same sort of lymph ran out, the tumour was less, the skin was of a natural colour, and the veins were contracted. A little lime-water and melrose were injected tepid into the cavity of the ulcer.

August 3. Two ounces and an half of liquor ran out of the sore: This
liquor

liquor was more of a purple colour, and less salt to the taste. It was dressed as formerly.

4th, The tumour felt as if divided in the middle, and as if it were falling to pieces; her appetite was better, the pain less; an ounce of liquor ran out; the dressings the same.

5th, She underwent what the women call a *weed*, which resembles the paroxysm of an ague. This day the liquor evacuated at the sore was in greater quantity, thinner, darker coloured, more foetid, and, when held in a spoon over a candle, did not coagulate. By drinking plentifully of thin warm liquor, she had a profuse sweat, which carried off the weed.

6th, The tumour was harder, the pain greater, the liquor foetid; a little digestive was added to the injection.

Two months attempts were made to melt down the hardness; but so unsuccessfully, that it increased, became more painful, and wasted her: yet she absolutely all the while refused to let it be cut off. Her left breast then inflamed, was soon brought to suppuration by proper applications, and cured in few days.

Soon after, five small tubercles were observed in the right arm-pit: which disappeared in a few days, upon a fungous excrescence thrusting out at the orifice in the breast of the same side, and some long tough substances coming out with the matter.

Some days after, a soft equal tumour, about the size of a large nutmeg, without pain or discolouring, started up at the interior side of the affected breast, the fungus in the orifice having retired at the same time, and the lips retorting, with all the very bad symptoms of an ulcerated cancer: which in a short time made her so miserable, that she was content to submit to the amputation of the breast; which was done successfully by the same young gentleman who, under my directions, had taken care of her from the beginning.

Some months after the wound was firmly cicatrized, and she strong and well, some knots began to appear in the arm-pit, and at the edge of the pectoral muscle. She was frightened for more cutting; and let them increase and spread, till now she seems to be in the way of suffering all the miseries of a cancer that cannot be taken away. My prognostic was too much verified in this patient.

The quick return of the cancerous knots, after the extirpation of the breast in this case, calls to my remembrance a problem which I have often wished to have a solution of, Whether ought cancerous tumours to be extirpated, or ought the palliative method only to be followed when they cannot be resolved?

The resolution of a cancer I acknowledge to be very rare; but having seen two such tumours, or at least what I judged to be such, cured, I would not exclude the supposition altogether.

To encourage others to tell their experience and opinion, I shall give mine.

Of near sixty cancers, which I have been present at the extirpation of, only four patients remained free of the disease for two years. Three of these lucky people had occult cancers in the breasts, and the fourth had an ulcerated cancer of the lip.

The disease does not return always to the part where the former tumour was taken away; but more frequently in the neighbourhood, and sometimes at a considerable distance.

Upon a relapse, the disease in those I saw was more violent, and made a much quicker progress than it did in others on whom no operation had been performed.

When an ulcerated cancer, that can be extirpated, is wasting the patient so fast, that it must bring death in a short time, there seems little doubt that it ought to be taken away, as the only means of prolonging life.

If an occult cancer is occasioned to a young healthy person by a bruise, or such other external cause, the hope of escaping a relapse would persuade us to extirpate it.

In all other cancerous cases, the earnest intreaty of the patients who have had the danger of a relapse fairly explained to them, and not the surgeon's persuasions, should make the extirpation be undertaken.

My practice continues to confirm what I have here said (which was written several years ago) concerning the frequent return of cancers, notwithstanding many attempts of different kinds to prevent it. Courses of mercury, drinking the decoction of guajac, aperient roots, millepedes, and such other attenuants and deobstruents, did no good. What did most
service,

service, was the keeping a part of the wound, made in the extirpation, open in the form of a perpetual issue; which retarded the return so long in some patients, that I flattered myself I had at last hit on the preservative against a relapse. But even in this I have been disappointed.

Since the above was first written *, I have seen many cancers return after extirpation; and very few that did not return, notwithstanding the use of *mercury*, *guajac*, *millepedes*, *verruca equina*, and a variety of other medicines, which were given with a design of freeing the blood of the cancerous matter. One woman, who had a large cancerous mamma extirpated, had part of the wound kept open in form of a perpetual issue, and remained long without a relapse; which made me hope such drains would be preservatives against a return of scirrhus tumours: but they have failed in several other cases.—Sea-water, taken frequently in such quantity as to purge gently, is said to have dissolved scirrhus tumours; but I do not know that sufficient trials of it have yet been made.

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Cure of an ULCER of the LUNGS by Blood-letting.

THE ulcer of the lungs is a disease so frequently fatal, that some of the ablest physicians make it a question, whether ever a consumption from that cause has been cured. And indeed whoever considers the important office of this viscus, its spongy texture, its perpetual motion, and the particular rapidity with which the copious blood pours through its vessels, will not be greatly surpris'd that a suppuration here should so little yield to the efforts of physic.

A good many different methods of cure have been tried; but none of them is much celebrated for its success. A new one has been lately recommended; which, in my humble opinion, is by no means absurd, I mean that of frequent bleeding in small quantities.

Young people of plethoric habits, and such as have been accustomed to frequent blood-lettings, are very often subject to this disease; and in these it is to be generally observed most acute, and to slide on the fastest to its catastrophe. In such patients, I should take Dr Dover's method of cure to be extremely reasonable, especially if it is used with proper cautions, and before the constitution is much drained of its natural fluids.

I shall offer the reasons that occur to me in behalf of this doctrine. Any body, I believe, will allow, that to heal the ulcer is to cure the disease; and this method, I think, bids as fair to do that as any. It is granted on all sides, that some degree at least of a fever is necessary to the making of pus; and that the quantity of pus will always be, *cateris paribus*, in proportion to the force of the heart. It is likewise undeniable, that the more the circulation is hurried, the constitution is the more heated, the purulent matter acquires the greater virulency, becomes the sooner thin, and is the faster reformed; while in the mean time the circulating fluids are attenuated, exalted, and expelled the faster. Thus the
whole

whole train of hectic symptoms is very remarkably influenced, or rather their degree of virulence is entirely determined, by the velocity of the blood. The resorbed pus occasions the hectic fever, and that again prepares new pus; that is to say, supplies fresh fuel to the disease. And thus the struggle is maintained till the heart ceases to beat.

Now, as blood-letting is the most effectual way to abate the force of the heart, it must of course diminish the quantity of pus, and alleviate all the bad symptoms that owe their origin to this fomes. The mere subtracting of acrimonious blood, too, seems to be no despicable advantage, since this diminution may easily be repaired by the addition of more laudable juices from the aliments; which, in this case, ought always to be of a mild kindly nature, easily elaborated, and for the most part acescent, to be administered frequently, and in small quantities at a time. And, besides, if bleeding takes off, or considerably abates, the hectic fever, it may come to be of no real expence at all, since by this means the great waste of fluids, by colliquative sweats, or diarrhœa, will be saved. For which reasons it might perhaps be, with proper cautions, ventured upon, even in patients that are already pretty much exhausted: seeing it is certain, that their vessels are still exquisitely full, and may, in proportion to their contracted state, even suffer a plethora; which appears often in the weaker sex, who are frequently visited with regular returns of their menses to the very last stage of the disease, notwithstanding all the loss they undergo by plentiful colliquative discharges.

But the good success of riding, and other exercises, in the cure of consumptions, may be objected to this reasoning, since these concussions and agitations of the body should, according to this scheme, by accelerating the motion of the blood, rather aggravate the malady, and spur it on to its last fatal stage, than contribute to its cure. This fact, at first sight, seems to shake the doctrine here advanced; but, when more narrowly considered, I am apt to think it rather strengthens it: For besides the advantages of corroborating the flaccid fibres, and compacting the melted fluids into a just density, there is perhaps a very considerable one procured from these exercises, by their enabling the vessels to throw out the purulent miasmata as fast as they are taken in; and as by this means an accumulation of resorbed pus is prevented, the hectic paroxysm, during which

which the ulcer is most supplied with new pus, is either quite cut off, or much mitigated.

In a word, the particular violence with which this disease is observed to act, and the uncommon dispatch with which it proceeds, in plethoric habits and warm constitutions, plainly seems to indicate this practice at least in such patients.

Blood-letting will, for the same reasons, be equally justifiable in all internal ulcers, though there seems to be the greatest necessity for it when the lungs are the seat of the disease, upon account of the abundant torrent of blood that rolls with so much fury through their numberless vessels.

Before I put an end to this paper, I must take the liberty to propose a few queries, concerning the management of consumptions by this method, which I shall submit to the consideration of proper judges.

1. Whether is it not a reasonable piece of caution to abstain from bleeding, as long as there are any well-grounded suspicions of abscesses yet unbroken in the lungs, since bleeding in that case would only weaken the patient to no purpose? And whether all the proper methods of detarging and expectorating ought not to be diligently used before bleeding is called in?

2. Whether it is not the most proper time to let blood when the patient is pretty much recovered from the fatigue of his last paroxysm, after his having cleared his lungs as much as possible by coughing?

3. Whether, in the very time that the blood springs, it may not be adviseable to make him draw in gently astringent, drying, and balsamic steams, such as of myrrh, mastic, &c.?

4. Whether the more volatile, detergent, and antiseptic medicines, such as aloes, myrrh, vinegar, kindled pitch, sulphur, &c. might not be happily conveyed to the lungs in this shape?

5. Whether there may not frequently be harm in insisting much upon expectoration? since by this means the ulcer is still kept crude; the plexus of new tender vessels is broken in forming; the lungs are robbed of that lymphatic and mucous moisture, which would much contribute to heal the ulcer (a); and their nerves are laid bare to every stimulating cause; whence

(a) This is in consequence of an observation made in an *Essay on the nutrition of Fœtuses*, Vol. II. Med. Essays, or No XI. of this Collection.

whence an incessant cough, and all its bad effects. May not antiseptic steams, and a mild acefcent diet, issues, &c. much take off the necessity of expectorating medicines? Are mild pacifics, (the preparations of our own poppies, especially their seeds, in form of emulsion), mixed in small quantities with balsamic, refrigerating, and gently detergent materials, to be allowed only at night? And even during the operation of the pargorics, will not the lungs, (if their tone is not much enervated, and the opiates are not too strong), when their vessels begin to be overburdened, be sufficient, of their own accord, in most cases, to expel the offending load, without the assistance of any more artificial stimulus? Does not the success of opium in the catarrh, even when the mucus is very thick and hard to be discharged, warrant this practice, and even invite us to it?

Lastly, would not the bark, and other medicines that corroborate without stimulating much, frictions, and gentle exercise, be necessarily used at the same time with bleeding, to assist in curing the hectic fever, and to prevent crudities, hydropic collections, tumours, and other bad symptoms, that might probably be introduced by loss of blood?

An uncommon DROPSY from a steatomatous OMENTUM.

CHRISTIAN SETON was subject to the erysipelas in her legs from her youth. At 31 years of age she married, but never conceived. Her menses left her when she was 39 years old. Three years after, viz. in July 1727, she perceived her belly turning bigger than naturally it used to be, which she imagined was occasioned by a draught of four wine which she had taken two years before. In August following, her legs also began to swell, when she asked the advice of some physician. He ordered her several purgatives and other medicines; notwithstanding which, her disease increased very fast.

When I first saw her in the beginning of October, her belly was swelled so big, as to reach down beyond the middle of her thighs when she was sitting. The bastard ribs, and *regio epigastrica*, were violently protruded outwards, and the point of the xiphoid cartilage was turned directly forwards. Her thighs and legs were œdematous, and double their natural thickness. The upper part of the trunk of her body, her face, and superior extremities, were greatly emaciated. She had no appetite for food; but had a thirst, though not violent. Her tongue was moist, but slimy. She was costive, and passed very little urine. The pulse was weak and frequent. The breathing was so difficult, that she durst not lie down, but was obliged to sit always in an erect posture. A perpetual cough, night and day, kept her from sleep; and with the cough she spit up a thick mucus. She was so weak as not to be able to stand. On striking the belly, a fluctuation of water was plainly felt. To all these symptoms was added one of the worst circumstances that can happen in such a disease, want of attendance, and of the common necessities of life.

Several

Several of the most pressing and uneasy symptoms in her case depending on the violent distension of her belly, I resolved to attempt giving her some relief by tapping her; which I performed in presence of my colleague Dr John Innes professor of medicine, Mr Charles Allan surgeon, and several students of physic; and let out six Scots pints or twenty-four pounds of water: which at first came off briskly in a stream, but in a little only dropped from the canula of the trocar, and at last stopped entirely before the swelling of the belly was near gone; though I took care, during the operation, to keep the abdomen tightly compressed with a belt and assistant's hands, and to clean the pipe frequently by introducing a probe through it. The patient bore the evacuation without the least fainting; and I left her easier, with the belt I commonly use on these occasions, well charged with the fumes of benzoin, mastich, and succinum, applied to her belly, and drawn pretty tight. In the evening, she took a cardiac mixture, with some drops of liquid laudanum; she slept well all night, and was considerably refreshed in the morning.

The regimen now ordered her was to drink none, or very little; but, when she was thirsty, to put a little bit of tamarinds mixed with crystals of tartar into her mouth; to eat fleshes, or with any other food to mix wine and spices. These might appear ridiculous directions for one in so much poverty: But the honourable Mrs Margaret Balfour of Burleigh, moved with her wonted extensive charity, had promised to supply every thing necessary for diet or attendance; and as long as my poor patient lived, the promise was most punctually and bountifully performed; for that honourable lady not only gave orders to her servants to execute whatever directions I gave, but carefully inspected the due execution of them. Every day, the patient's belly was well rubbed with flannels strongly charged with the aromatic fumes. Every fourth day, she had a purgative given her of *Decoct. amar. cum dupl. senn. unc. ii. Oxytel scillit. unc. sem. Syrup. de rhamn. unc. i. Pulv. jalap. scrup. i. Misc.* And four times every intermediate day she took the bulk of a nutmeg of an electuary composed of *Rad. helen. irid. florent. gum. ammon. and honey*; washing each dose down with one fourth of the following liquor, *Decoct. amar. unc. iv. Sp. succin. drach. ii. Misc.*

By the use of this sort of diet, and of these medicines, she passed very

large quantities of water both by stool and urine; and in a few weeks all her symptoms went off, except the swelling of her belly, which was however greatly diminished, and gave her no uneasiness.

In the month of February 1728, having sat long in church, exposed to the air, which was then very cold, and having neglected to take her medicines some time, the quantity of her urine lessened much, she became costive, and the former bad symptoms returned. Nor could I after this procure the evacuation of water, which had been so beneficial to her, by any medicines; so that she in a short time relapsed into as bad circumstances as when I saw her first, with the addition of a very sharp pain under her short ribs, especially of the left side.

On the 2d of July, I again tapped her with a larger trocar than what I had formerly made use of; and drew off first mucus, then pus, which sunk immediately to the bottom of the vessel where the mucus had been put, and had white membranes mixed with it. These two liquors, mucus and pus, ran alternately, till I had evacuated in all sixteen pounds, when no more would run; and in the time of the evacuation, I had frequently been obliged to draw out the tough slimy stuff, which stopped the pipe with a probe. When I thrust the probe softly into the cavity of the abdomen, it was soon resisted by a firm solid substance, which on the least touch bled.

The lower part of the belly subsided remarkably on this tapping; but the *regio epigastrica* yielded nothing.

The patient being no way relieved by this evacuation, I again tapped her on the 14th of July, but was resolved to prevent the matter contained from being stopped by a narrow canula; and therefore performed the operation with a trocar as large as my little finger, but could bring away only eight pounds of purulent matter. The poor patient, daily turning worse, died ten days after; and I was allowed to examine the body.

The body being laid on a table, had the appearance represented in Plate III. fig. 1.: The belly, A, hanging down over the thighs, and monstrously swelled every where; but with a depression D crosses the belly about midway between the navel B and the sternum, the under part of which was advanced, and the point of the xiphoid cartilage E was directed straight forwards. The hypochondria were also considerably raised. The thighs

F and

F and legs were greatly œdematous, and the rest of her body was much emaciated.

The *tunica cellulosa* of the abdomen was very thin, without any water contained in it. In cutting through the muscles and peritoneum, on the left side of the navel, two pounds of yellow water ran out; and from the cavity G (fig. 2.) where this was lodged, ten ounces of pus were taken, with white tender membranes swimming in it. Having cut the containing parts from the navel to the left loin, no more water appeared, but eight ounces of pus were collected. All round the cavity, in which the water and pus were lodged, I observed a white hard substance, seeming to be composed of conjoined vesicles, and adhering strongly to the peritoneum. This I dissected away from the peritoneum, till, in cutting upwards, I had reached half-way between the navel and sternum; when it adhered so very close, and became gradually so thin, that I was of opinion I would sooner and better discover what it was, and how far it reached, by cutting it through at H, and opening into the cavity: which therefore being done, I raised the containing parts strongly, and looking behind them saw this knotty substance BB adhering to the peritoneum three inches further up; and then, separating from the peritoneum, it was extended backwards, and supported a considerable quantity of water D lodged above it. I next with my scissors cut close off from the peritoneum that substance, which, being extended from one side of the abdomen to the other, served as a sort of transverse mediastinum or diaphragm to divide that cavity into two. After this, seeing nothing more above the navel in danger of being destroyed, I divided the containing parts in the common way of dissection, and turned up the two quarters of the teguments now raised on the ribs, to have a better view of the vesicular substance BB adhering to their internal surface. It consisted of a fatty membrane beset with vesicular bodies, full either of mucus, or of a white hard steatomatous substance. The *regio epigastrica* C (fig. 1.) was exceedingly enlarged; and out of the cavity D (fig. 2. and 3.) formed in it, I took with a sponge thirty pounds of water, which had pressed out the surrounding bones, and had thrust the diaphragm considerably upwards. I next dissected the teguments from the vesicular body F (fig. 2.) as far

as it reached, which was to the *ossa pubis*; and then divided them in the ordinary way.

All the teguments being thus removed, I viewed carefully the contents of the abdomen yet in sight. At the upper part, I saw the great cavity of the epigastrium D. Below this appeared a very large membranous sac C, of a brownish black colour, distended with air, and reaching from the extremity of the cartilages of one side to those of the other, when it sunk down under both hypochondria; the middle part of it was much the largest, and no division into cells, or longitudinal ligaments, were to be seen on it; though I found evidently afterwards it was the great arch of the colon. The part of the fatty membranous body left, when I cut this, in raising the two superior quarters of the teguments, mounted over this sac; and then sinking backwards adhered to another viscus, which I could not yet discover, without putting some parts out of their situation; and from the under part of this same sac depended a white vesicular fatty substance, with large blood-vessels, I, spread on it: This at first was thin; but gradually as it descended became thicker, till it was hid by the anterior lamella, which had been dissected off from the peritoneum. When this last was raised, I softly thrust my hand into a large bag formed between the two, as far down as the *ossa pubis*, where they made one continued substance. Besides these, I could observe no other viscus, except the cæcum or great sac of the colon K, lodged in the cavity of the right ilia. Wherefore I dissected that vesicular body away from all the parts to which it was contiguous or adhered; and, in cutting, remarked, that all the little cells opened in this dissection poured out water. When this body was wholly removed, (see fig. 3.), I could not at first discover any thing in the cavity below, except a flat circular protuberance L, lying on the vertebræ, covered with a dirty black-coloured membrane; and this, in a great many places, had a white tender membrane, resembling the pellicle formed on boiled milk when it cools, lying upon it. The cavities of the loins were very large, and filled with water as well as the pelvis, and under the water pus was every where found. When these liquors were taken out with a sponge, the surface of the cavities had much the same appearance with that of the large middle protuberance. The cellular substance

stance surrounding the pelvis was two inches thick, and distended with water and mucus.

Looking at last narrowly to the great protuberant body, I perceived some faint resemblance of the convolutions of the small guts appearing through the black membrane, and discovered the colon MN in the same way in the loins. When the membrane was dissected off, all the intestines came in view, of the colour and size of which they are commonly found in hydropic emaciated bodies; but the small guts and folds of the mesentery, where they were contiguous, slightly adhered to each other by a weak sort of membrane, which, when tore by gently drawing the viscera, yielded water out of its cells.

The great guts were distended with air, and in a natural enough condition.

The mesentery was shorter than ordinary, but otherwise found.

The stomach, hid in the great epigastric cavity, was very little larger in its transverse diameter than the small guts, but of a natural colour, without any black membrane over it. From its fundus, the remains of the cut omentum depended, which was the vesicular substance I at first divided in opening the abdomen.

The liver was quite hid under the bastard ribs; and adhered so firmly to the livid peritoneum by its membrane, which was about a quarter of an inch thick, that I could not observe its colour or substance, till I had taken off the membrane, when this great bowel looked pale, and had very little blood in its vessels.

I found no concretion in the gall-bladder.

The spleen was much in the same condition with the liver.

The pancreas was pale and hard.

The kidneys were in a natural condition, but with little blood in them.

The ureters were of the ordinary size.

The bladder, ovaria, *tubæ Fallopianæ*, and uterus, were all found, only covered with a thick livid membrane.

The water and pus taken out with sponges amounted in all to forty pounds.

I directed a servant to carry home the large vesicular body which occupied all the anterior part of the abdomen, and there examined it. It consisted

consisted of two lamellæ, which were thin above, but gradually turned thicker as they descended, till at the lowest part, where they united, they were six inches thick. Each was covered all over with a smooth membrane, only the anterior was ulcerated at its superior external part. Several ounces of purulent matter, with pellicles swimming in it, were taken out from the cavity formed between the laminæ. When the external membrane was separated, each seemed to consist of vesicles of different sizes, some of which were distended with water, others with mucus, and a third sort with a steatomatous stuff. So far as could be discovered, there were no communicating passages immediately from one vesicle to another.

From the whole, there is reason to conclude this body to have been the omentum diseased, which very probably might be the cause of the dropsy, as well as tumours of other parts frequently are, of which I have seen several examples.

Whether is it peculiar to the membranous parts, when suppurated, to have pellicles, like to that which gathers on boiled milk, mixed with the pus? I have seen them after inflammations of the guts, pleura, and in the foregoing history of the omentum.

Whether are those pellicles the membranes separated and turned tender by soaking, or the particles of the pus adhering and pressed firm?

Improvements in performing the Operation of the PARACENTESIS or Tapping of the BELLY.

THE place where chirurgical writers determine the perforation to be made with the trocar in tapping the belly, is four or five inches below, and as much to a side of the navel, or the point where a line at that distance from and parallel to the *linea alba* would be intersected by another line drawn perpendicular to the *linea alba*, at four or five inches below the navel. If this point is supposed to be determined on a healthy man of middle growth and stature, it certainly is a very safe and convenient place for making the puncture: for it is sufficiently dependent, especially when the person lies on the same side; there are no thick fleshy bellies of muscles to pierce; nor are the muscles entirely tendinous, but are become tendineo-carnous; and at this place there are no large blood-vessels or nerves in hazard of being wounded: All which advantages no other part of the abdomen has. But then this rule of measuring four or five inches is certainly not to be applied to hydropic people; it being very precarious, and consequently very often dangerous: for though the distance is taken in full measure when the abdomen is distended, yet, when the belly subsides, the perforation will be found nearer to the navel in proportion to the degree of distension. For instance, suppose that the anterior part of the abdomen is distended by water to double its natural length and wideness; that when the water is drawn off, this cavity is contracted to its natural size; and that all the parts have been equally stretched, and are again equally contracted: then, though four inches were taken both ways from the navel, it is plain, that, after the contraction, the distance each way will be but two inches; so that the perforation,

tion is not depending enough, the rectus muscle is pierced and probably some of the larger branches of the epigastric vessels are wounded.

What undoubtedly is meant, is to make a proportional allowance for the quantity of distension : and some authors have said so much ; but none of them, except Garangeot, have laid down any other general rule for choosing the place of tapping. He indeed says (*a*), that the puncture ought to be made in the middle between the navel and spine of the *os ilium* : But as this spine is of a considerable extent, his rule is much too uncertain ; especially considering, that the precise point to be pierced can be determined in all subjects, and in every degree of distension which the belly suffers in dropsies, by only remarking, that in a sound state a point four inches below and to a side of the navel, is the middle betwixt the navel and anterior spinal process of the *os ilium*, and that the muscular parts of the abdomen are near equally stretched in the *hydrops ascites apertus* : whence it follows, that this middle point between the navel and this spinal process, is invariable, or nearly so ; and therefore is the part where the perforation ought always to be made in tapping.

Till of late that Dr Mead, by pressing on the abdomen with an assistant's hands, while the water of the *hydrops ascites* was evacuated, discovered the sudden taking off the pressure from the descending aorta in such subjects as scarce have blood enough to fill the vessels of the body, to be the true reason of the syncope, inflammation, and great distension of the vessels of the abdominal bowels, and particularly of the intestines ; surgeons were very careful to draw off a small quantity of water at once, and rather chose to repeat the operation more frequently, though they were sensible at the same time of several disadvantages attending their method : for besides the pain and uneasiness to the patient, and the danger orifices made any where in the teguments of hydropic people are in of mortifying, the guts still lose more of their tone by soaking long in water, and the air being necessarily admitted by the canula into the cavity the abdomen, is liable sometimes to rarify, distend the belly, and form a tympanites, and never misses to hasten the putrefaction of the water ; from which a train of various bad symptoms must follow.

All these evil consequences might then be prevented, by drawing off
all

(*a*) Traité des Operations du Chirurgie, tom. i. chap. 6. art. 1.

all the water at once, and preserving the pressure still on the belly, which can be supplied by art, but ought, for greater safety, to be done gradually and equally as the water runs out; which neither the pressure with hands in time of the operation, and applying a bandage afterwards, which is the practice in England, nor the swathing with a towel immediately afterwards, as I have seen done in the hospitals at Paris, are rightly calculated for; and therefore these several years I have always used a belt, of the form in Plate III. fig. 4. made of fine flannel, covered with strong linen. The body of the belt, A, is only so wide as to reach from the spine of the one *os ilium* to that of the other; to one end of this body strong tapes or ribbons B are sewed at a little distance from each other, and to the other end as many well-polished buckles C are put. Near the inferior side of the belt, and at a small distance from each end, a little window DE is cut, which can be shut with two buckles G, and straps F.

When the operation of the paracentesis is to be performed, I mark with ink the middle point between the navel and anterior extremity of the spine of the *os ilium* of the side which I design to pierce: then I apply the belt, with the flannel side next the skin, well charged with fumes of *benzoin*, *maslich*, and such other drying and corroborating medicines; taking care that the point of the skin formerly marked with ink, shall be in the middle of one of the windows or openings of the belt: after which, a linen compress, or piece of flannel, is put on the back, to defend it from being hurt by the buckles, and a long piece of flannel three or four fold is put under the buckles, that they may not fret the skin. And, lastly, the straps or tapes are put through the buckles, and drawn a little tight; by which the water is pressed in greater quantity to the part of the abdomen where there is the least resistance, which will be the part uncovered by the belt, or the open window; and therefore that part becomes more prominent and tense, which facilitates the perforation, and makes a greater distance there between the containing parts and viscera, and consequently makes less danger of the guts, &c. being wounded by the point of the trocar.

Gradually as the water is drawn off, the straps are pulled straighter; and if the patient will be ingenuous, the same pressure can be kept on

the abdomen all the time of the operation, and after the entire evacuation, as was on it before one drop of the water was taken away; because the operator has a very certain gage, the breathing, to judge by: for the difficulty of breathing, which hydropic people labour under, being wholly the effect of the water pressing the diaphragm upwards, and thereby straitening the lungs, any force equal to that of the water pressing all the parts of the abdomen equally, will have the same effect. For this reason, the patient must, from time to time, acquaint the surgeon if he is sensible of his breathing more freely, when the straps are to be drawn tighter, till the patient judges the difficulty of breathing to be the same as it was formerly. In this way I have drawn off, more than once, from very feeble emaciated patients, sixteen Scotch pints or sixty-four pounds of water at once, without the least faintness or uneasiness.

After all the water is evacuated, which is greatly assisted by the pressure, a pledget and plaster are to be put on the orifice, from which the canula was taken, in the common way; and a compress being applied over these, the window is to be shut on this, and brought to the same tightness with the rest of the band. At pleasure this window can be opened and shut, and the wound can be dressed; and the whole belt may, as occasion requires, be slackened or straitened.

In Plate III. fig. 4. this Belt is represented.

- A Its body.
- B The straps.
- C The buckles.
- D The window.
- E The part of the belt that closes up the window.
- F The small straps.
- G The little buckles.
- H The window shut up.
- I The straps and buckles.

The belt just now described is what I have only made use of hitherto; but have sometimes been sensible of inconveniencies in applying it when the belly is very greatly distended; for, in such a case, the *ossa innominata* kept

kept the belt from being rightly applied to the lower part of the belly, which is stretched down over the patient's thighs ; the superior part of the abdomen, being considerably smaller than the lower, is not sufficiently straitened ; and after the operation is finished, the belt is liable to be gathered all in wrinkles round the loins, especially if the patient is restless and careless.

To prevent these inconveniencies, I think a further improvement may be made to the belt. See Plate III. fig. 5. Let a flanting flap K be added to its inferior edge ; from which let two straps LL, with buckles at their extremities, go out to pass between the patient's thighs, and to be fastened to other straps MM, which come out from the upper edge of the circular band, or to a scapular bandage brought over the patient's shoulders. It is evident that the flap K will compress the hypogastric region, which the circular belt could not reach ; and that the additional straps, being tightly drawn, will keep the circular band stretched at its full breadth.

The Dissection of a Cataractous EYE.

DECEMBER 15. 1736, In presence of Dr John Taylor physician, and of Mr John Douglas surgeon in this place, I dissected the eye of a man which had been examined while he was alive by several physicians and surgeons, who all unanimously declared the man to labour under a cataract of that eye.

The cornea of this eye was perfectly pellucid, without any opacity in it:—The aqueous humour seemed to be in due quantity and quality:—We could discover no fault in the iris:—The opaque crystalline lens inclosed in its capsula was not so large as it is commonly in a sound human eye: instead of being circular, it was of a triangular form; and its interior convexity was scabrous and unequal, of a yellowish white colour, the yellow cast appearing much stronger after the eye was opened than it did while the eye was entire:—The connection of the crystalline inclosed in its capsula, to the ciliary circle, and to the vitreous humour, was much weaker than it is for ordinary; so that by reclining the eye to one side, after the iris was taken away, the weight of the crystalline made it separate on any side from which I reclined it:—The posterior convexity of the crystalline was smooth, but of a more yellow colour than the anterior part of the lens.

When an incision was made into the capsula, the included lens separated from it, without our being able to perceive any connection between them:—The capsula was opaque, but of a much whiter colour than the crystalline itself:—The crystalline was nearly of the same consistence all through, without either watery or gelatinous exterior substance, or being harder and firmer towards the centre.—It was all composed of a great many strata of a greenish yellow substance, which became more on the green cast as we separated the lamina nearer to the centre, where we could observe no firm nucleus:—The vitreous humour was all clear and transparent:—We saw no fault in the retina:—The colour of the internal surface of the choroid coat did not seem so deep as it commonly is.

Four Cases of the Tumefied OVARIIUM.

SOME years ago, I opened the dead body of a married woman, aged thirty-six years; who, I was informed, had always been healthy till two years before her death; when, her menses stopping, she imagined herself with child; and her belly having gradually turned bigger, every thing was prepared for the birth. But after the tenth month of her supposed pregnancy was completed, her belly entirely subsided, upon a considerable discharge of water *per vaginam*. In some little time after which, her menstrua returned; and having undergone two or three periods of them, she was for a second time obstructed, with the other common symptoms of pregnancy. At the end of the ninth month, when she had the same appearance with other women in such condition, she was seized with bearing-pains, and continued several days in labour: the fatigue of which at last wasted her strength so much, that she died.

The abdomen appeared all over greatly distended; and at the under part, I felt through the teguments a hard solid substance, distinct from all the other parts.

The teguments of the abdomen being cut, I absorbed with a sponge, out of the cavity, sixteen pounds of a dark-brown coloured water; which was so acrid, as to give a pricking pain to my fingers when soaked in it. From the hollow of the ilia, I took out some spoonfuls of a white-coloured mucus.

The internal surface of the peritonæum, and the external of all the bowels, were black.

A spongy body of a lead colour grew out, and received vessels from the *intestinum ilium* and part of the mesentery.

The spleen was softer than ordinary.

The liver was grown to the peritonæum in all its convex surface; it appeared of a lead colour externally, but was red when cut.

I found in the gall-bladder six concretions, resembling small bramble-berries in their black colour and unequal surface.

The inferior part of the abdomen, from a little below the navel to the *ossa pubis*, was filled with a large body, which was adhering to the peritonæum and guts contiguous to it. The greatest length of this substance was stretched transversely from one *os ilium* to the other, and was twelve and two fifth inches; the breadth of it from the *ossa pubis* upwards was seven inches, its thickness five and a half.

This substance being removed, I saw the *vesica urinaria*, uterus, and right ovarium, with its *tuba Fallopiana*, in a natural state, but could not discover the left ovarium; and the left tuba was cut away with the preternatural body above described, to which I afterwards found it firmly adhering.

The blood-vessels were very large, and observable on the surface of that large body, which had two strong membranous coats covering it all round; the exterior of which was easily dissected off, by a cellular substance being interposed betwixt it and the internal membrane, which contained a great many vesicles of different bulk, distended with mucus, or with a firm steatomatous substance; and in some of the bags both mucus and steatoma were found.

From which structure, and the preceding account of the disease and dissection, it is pretty evident, that this preternatural body was the left ovarium monstrously overgrown and distended.

HIST. II. A woman of 21 years of age, while under the violent pains of labour of her first child, was very impatient, and tossed from one place to another. Soon after, she was sensible of a weight in her right groin, which, in the different postures of her body, removed always to the most depending part. However, as it was not attended with pain, she did not complain of it for some months, till, the weight increasing, and a swelling and hardness being plainly felt in that groin, she asked advice of some physicians and surgeons; who applied external medicines, and gave internal ones, without her being at all relieved.

A year and a half after her child-bed, Dr Alexander Dundas, Mr James Robertson surgeon, and I, were consulted about her. Her body was at this time wasted to skin and bone, as the common phrase is; and so weak, that she could not turn herself from one side to the other. Her pulse was very weak, but quick. She had no appetite for food; and she no sooner took any, than a feverish paroxysm was brought on, which terminated in a sweat. The thirst was perpetual, and scarce to be quenched. She had constantly loose stools; and passed green, violently fetid fæces. She slept none in the night; and towards the morning had generally a large sweat. Her menstrua had not appeared of a very long time. The right side of her belly was considerably swelled: and we could feel with our fingers a hard tumour below the teguments, extended over that whole side; so that we could not be sensible of its terminating either at the bastard ribs or *os innominatum*. This tumour pointed considerably outwards about four inches below the navel, and as much to a side of the *linea alba*; at which place she had for some time before complained of the greatest pain. Here the teguments felt thin, and a liquor fluctuated evidently below our fingers.

The prognosis we made will easily be presumed not to have been very favourable. And, after acquainting the relations of our patient's danger, we proposed opening that prominent part of the tumour, as the only remedy that had the least chance of relieving her, though the consequences even of that operation were very uncertain. Having obtained the consent of all concerned, Mr Robertson made an incision of an inch long into the part where the greatest appearance of pus was; but we were all not a little surprised to observe nothing but a great blast of wind to follow the lancet, and the belly to subside considerably in an instant. The patient complained less of pain that night. Next day, a large quantity of green fetid fæces, such as she had purged of a long time, was evacuated at dressing the wound; and the two following days the same kind of matter was discharged, but the quantity of it diminished daily; and in the mean time her diarrhœa decreased in proportion, and she slept tolerably well all night.

The fifth day after the incision, neither wind nor fæces came by the wound; but it discharged about four ounces of good pus.

From

From this time, we entertained hopes of her recovery: For the diarrhœa was quite stopped, her appetite became better, her strength increased, the hectic fever and sweatings gradually diminished, and she slept well. An analeptic diet of jellies, broths, asses-milk, &c. was prescribed her; and cooling emulsions, with gentle opiates at bed-time, were given. The ulcer yielded a moderate quantity of well-digested pus, and the hard tumour of the abdomen diminished considerably; so that in two weeks we could press the points of our fingers betwixt the ribs and its superior extremity, and betwixt the *os innominatum* and the lower circumference of this hard swelling.

After a month's dressing, we discovered a sinus going out from the old orifice, and extended under the teguments about four inches down, and outwards, which Mr Robertson cut open; by which the surface of the tumour being laid bare, we endeavoured to encourage the suppuration as much as possible, by gentle escharotics, mixed with digesting balsams, applied to the ulcer, and emollient suppurating poultices laid over the whole hardness. The discharge, obtained by these, daily wasted the tumour; and, in three months, she seemed to be in perfect good health, and refused the ulcer to be kept any longer open, though there was still a hardness and swelling to be felt some inches round the orifice; so that we were obliged to cicatrize the ulcer.

She continued about two years free of all complaints, when a new supuration came on. But she was so afraid of being put to pain by making new openings, that she would allow none of us to be informed of her indisposition; but managed it herself, with the advice and assistance of some good women whom she confided in. One of whom told me, after her death, that, frequent suppurations coming on, and the small orifice made by the pus soon closing, her former bad symptoms gradually appeared; and, having struggled in a miserable way about three years from the first beginning of her relapse, she at last sunk under the disease, and died.

The account the patient gave of the first rise and symptoms of her disease, seems to lead one to judge the ovarium to have been affected; and the ovarium being supposed monstrously swelled, adhering to the colon, at last inflamed and suppurated, with the pus eroding a hole through the coats of the ovarium and the contiguous adhering colon, will readily account

count for all the phenomena in this case, which, at first view, seem attended with so many difficulties.

HIST. III.———aged twenty-six years, of a delicate weak constitution, in bearing her fifth child, was put to most violent pain by her midwife pulling away the placenta indiscreetly; which pain, however, after some hours, abated considerably, and continued moderate till the second day after, when she complained of a most racking deep-seated pain of her left groin. There was no hardness, swelling, or discolouring, to be observed. When she attempted to lie on the left side, the pain was greatly increased. Her pulse was quick, but weak. Her thirst was excessive, her belly costive, and the quantity of urine small. The lochia were in sufficient quantity. She was leaner and weaker than ordinary, and often complained of being faint.

Emollient eccoprotic clysters were injected; she had almond-milk given for drink, and farinaceous flabs for food. When faint, she took a spoonful of a cordial mixture. The pained part was frequently fomented with emollients. The symptoms still increasing, I observed, on the eighth day, a large tumour below the muscles, extended from the *os pubis* to the superior part of the left *os ilium*, and the skin above it of a red colour. Her strength by this time was so much spent, that she could scarce turn herself in her bed. Lying on either side tortured her so much, that she was obliged to lie constantly on her back. She breathed with great difficulty, and frequently fainted. Since therefore no hopes of resolving the tumour appeared, I applied a suppurative cataplasm all over it, continued her cordial, and every evening gave a small dose of opium.

She continued in this miserable and extremely weak condition for some more than two weeks; and at last was attacked with a vomiting and diarrhœa, which continued two days, till the purulent matter of the tumour, eroding the teguments about two inches above the ring of the external oblique abdominal muscle, was discharged in a considerable quantity: After which the vomiting and diarrhœa stopped, the fever diminished, the pain abated, and she began to sleep calmly.

The orifice of the ulcer being small, I proposed to enlarge it by cutting; which she absolutely refused to suffer, as she had done also my opening

the tumour when I first was sensible of matter fluctuating in it. A tent charged with basilicon and red precipitate was introduced, and the former cataplasm continued. Some days thereafter, two other small holes were made by the acrid pus, at a little distance from the former, which gradually were enlarged by the constant use of the escharotic powder. The liquor discharged by these orifices was sometimes purulent; but much oftener was glairy mucus, resembling the white of an egg.

The orifices being kept open, and the suppuration encouraged, by continuing the method of dressing mentioned, the hardness gradually melted down, the bad symptoms went off, and she recovered strength; but for several months was often attacked by violent asthmatic fits, from which the *oxymel pectorale* of the Edinburgh dispensatory never missed to relieve her. Since this time she has enjoyed as good health as ever, and has born several children.

The manner of this tumour's increase, its being confined to one side, without any stopping of the lochia when the inflammation was violent, and without any discharge of pus *per vaginam* when the tumour suppurated, and the liquor evacuated by the orifices of the teguments being mostly mucus, all conspire to point out the ovarium, and not the uterus, to have been affected.

HIST. IV. In a letter from Mr Hugh Sutherland surgeon, now physician, at Kirkwall in Orkney, I was desired to give advice in the case of a gentlewoman, who, six weeks after being delivered of a child, complained of a pain and hardness at the lower part of the right side of the belly; which, afterwards spreading upwards, and to the left side above the *os pubis*, gave her great trouble. Her menstrua had not appeared for some months after childbed; her urine was in small quantity; she was constantly hectic, had no appetite for food, and was reduced to great weakness and to skin and bone.

Mr Sutherland informed me, that an hystERIC plaster, besmeared with *ol. succin.* had been applied to the tumour; and that it was afterwards embrocated with a liniment composed of *Ung. alth. Sp. sal. ammon. Ol. succin. et anis.* She had taken the stomachic bitters some time, and used *sal prunel.* dissolved in her ordinary drink. By these medicines her menstrua were

were brought to be regular, the urine came to be in good enough quantity, and the hectic fever seemed to be gone: but her appetite still continued bad; and, after eating, she was sick and uneasy. Her belly was so costive, she scarce had a stool once a-week. She still was weak and lean. The pain, hardness, and tension of her belly, increased evidently. Though she slept much, both in the night and day; yet she neither was strengthened nor refreshed, but always awaked weary and fatigued.

In answer to this account, I wrote Mr Sutherland, that I suspected the right ovarium to be tumefied; and in case my suspicion was just, probably he would, upon inquiry, find, that the progress of the tumour had been much in this manner. Before any swelling and hardness discovered themselves, our patient was sensible of a weight, which changed its seat to different depending parts of the pelvis, according to the different postures of her body. The increase of the tumour was from below upwards; and when once it became so large as evidently to make the teguments of the belly prominent, the tumour was fixed, and would shift place no more. If there was no suppuration yet begun, the pain would be but obtuse, without any external redness or hardness in the teguments, and without fever, thirst, &c. If a suppuration was begun, all these symptoms, which I just now supposed her free of, would be appearing.

On the supposition of no suppuration, I was of opinion the tumour should, if possible, be resolved; and therefore proposed to foment the swelled part frequently with an aperient resolvent fots, and to keep a cataplasm made with the emollient *farina*, a considerable proportion of *galbanum* dissolved in the yolk of an egg, some *ung. alb.* and the liquor for fomentation constantly applied to the part. In the mean time, she should continue the use of the stomachic bitters, with pills compounded of the stinking gums, and a small proportion of aloes; should be ordered the lightest, easiest digested, and least heating food; and should drink whey, barley ptisan, or wine and water.

If the symptoms of suppuration were come on, it ought to be forwarded as much as art could.

Some months after I had sent this letter, an answer was delivered to me from Mr Sutherland, by my patient's husband, acquainting me, that the progress of the tumour had been precisely in the manner I had de-

scribed, but without any of the symptoms of suppuration: That this lucky guessing at symptoms I had not been informed of, and of which they had not taken the least notice before my letter, had given our patient great courage, and had made her punctually observe the directions I had mentioned: by means of which the tumour and pain were altogether removed, without any observable evacuation of matter any way; and my patient was healthy and strong.

Since her recovery she has born children, and continues in a good state of health: only that she is sensible of what she calls a weakness in that side; and after travelling and riding, she feels pain where the tumour was formerly.

N^o 27.

ARTIFICIAL PASSAGES for NATURAL LIQUORS.

A GENTLEMAN had been plagued with a tedious tooth-ach, which occasioned a very hard tumour above the joining of the cheek and gums of the second *dens molaris* in the upper jaw on the left side. The tumour having suppurated, broke outwardly on his cheek; the matter flowing out of the ulcer was for some time very fetid, and several carious pieces of bone came out of it. This ulcer continuing long, the patient came to this place with Dr Hugh Sutherland, now physician in Orkney.

There was then in the ulcer a tent about the size of a goose-quill, an inch and an half long: when the tent was taken out, it was covered with purulent-like matter; but upon leaning his head forward, and to the left side, a clear liquor, resembling glairy spittle, dropped out. No such liquor or pus had ever run out of his nose upon reclining his head to the right side and downwards. The fore had no fetid offensive smell. A probe gently bended, being put into the fore, was turned in different directions in a large cavity formed of bone, lined with a smooth tense membrane, which covered the bone every where that we applied the point of the probe. The roots of the rotten tooth, which began this trouble, and had often been attempted to be drawn by different tooth-drawers, were still fast in their sockets. Dr Sutherland and the patient both informed me, that they had several times observed a thickness, and felt what they thought to be a fluctuation of liquor in the palate or root of the mouth, which there was not then any appearance of. The patient was otherwise in good health.

By cutting the gum between the roots of the rotten tooth, I made way for a thin piece of iron, which I pushed forcibly in between these roots; and then thrusting it to a side, I prised the one root inwards out of its socket, and made the other so loose, that it came afterwards easily out.

A small gimblet being immediately put into the farthest back socket, I endeavoured to make it pierce into the *antrum maxillare*, but could not direct it so far back. To give a discharge of the mucus into the mouth, and to prevent its running out at the orifice in his cheek, till the swelling of the palate should give an opportunity of making a more effectual drain, I laid aside the tent; and, pushing a shoemaker's awl from the joining of the gums and cheek into the sinuous ulcer near the aperture made into the antrum by the former caries, by the means of a very flexible probe, I introduced a small cord into the wound made with the awl, and brought an end of it out at the external orifice of the ulcer, desiring the mouth to be frequently rinsed with brandy, to render the new wound callous soon.

The patient's business obliging him to return home, he went away with this seton; which being taken out some time after, this new passage shut up as well as the external orifice: soon after which the palate swelled; and, being opened by Dr Sutherland, some small pieces of bone came out, and our patient has been well ever since.

HIST II. In consequence of a toothach and rotten root, a tumour rose in a young gentleman's cheek, which had been opened in the inside of his mouth, and a glairy clear matter was evacuated: but the incision closing soon, the tumour again appeared; and, when I first saw him, was as large as a small golf-ball, filling all the hollow of the cheek, and being considerably prominent. I judged it to be of the encysted kind, forced out of the remains of the rotten tooth: but the tumour not evacuating at the sockets, Mr John Douglas, at my desire, opened it with a lancet within his cheek. Clear mucus being pressed out at the orifice, the tumour subsided; when we plainly felt three exostoses pointing towards each other, between which the sac had been nitched. One of the exostoses rose from the root of the nasal process of the maxillary bone: the second grew out from that same process, or from the anterior orbital process of the *os malarum* near to the orbit: and the third, which was the largest, resembling, when felt through the teguments, an old cock's spur, rose out of the cheek-bone. We could be sensible of no bone being bare or spoilt by a probe introduced at the wound; nor had we reason, from the nature of the matter evacuated,

cuated, to judge that there was any carious bone. A tent, with a thread hanging to it, was put into the wound; which was continued some weeks, brandy and melrose being frequently injected into the empty cyst, and the patient rinsing that side of the mouth often with brandy. After we thought the passage callous, the tent was no more used, and the patient has had no more return of the tumour.

HIST. III. Upon drawing the roots of a rotten tooth of a young lady, who had a tumour resembling the one described in the former history, a yellowish-coloured thin liquor flowed out of one of the sockets; this liquor had a great many particles resembling oil swimming on its top, but had no fetid smell. The swelling immediately subsided; no exostosis was felt; a small probe introduced into the hole of the socket could not be made to touch any bare bone in the circumference of a large cavity it was put into; nor could we discover the passage by which the liquor came from the external cystitis into the socket of the tooth. The management of this case was the same as of the preceding; the oily particles appeared several days in the liquor that flowed when the tent was taken out; at length they could not be observed. The lady has continued well, and free of swelling.

The CURE of an ULCER of the CHEEK, with
the superior falivary Duct opened.

MR. KER of Frogton, a young gentleman of a delicate constitution, and threatened with a consumption from an ulcer in his lungs, was seized, after riding in a cold night, with a very hard tumour about the middle of his left cheek. The gentlemen who attended him endeavoured at first to resolve it: but, observing a suppuration to come on, it was opened with a lancet on the inside; and afterwards an external orifice was also made, and escharotics were applied to waste down the hard stool of the tumour that still remained. When no more hardness was felt, his surgeon endeavoured to incarn and cicatrize, but was disappointed by a constant plentiful discharge of a thin clear lymph. The orifice was again enlarged; and it was dressed a considerable time with astringents and driers in different forms, but without any success.

In September 1727, being accidentally in the neighbourhood of Kelfo, where Mr Ker lived, I was sent for thither, to advise with Drs Abernethy and Scott, physicians there, and with Mr Jamieson surgeon, concerning his cure. The external orifice in his cheek was as large as would have received the point of my thumb; and, at the bottom of it, we could distinctly see some part of the superior falivary duct laid bare, with a hole in the outer side of it, large enough to allow the button of a middle-sized probe to enter it; and, when he moved his lower jaw at our desire, the saliva ran out plentifully at that orifice. When the jaw was not moved, a very small quantity of the spittle oozed out; but, in time of dinner, it made a napkin, laid eightfold over the plaster that covered the ulcer, wet all through.

We agreed to make an artificial opening for the saliva into his mouth, which I did in the following manner: Having with two fingers of one
hand

hand stretched his cheek outwards, I directed the point of a large shoemaker's awl, which I held in the other hand, into the open breach of the duct, and thrust the awl obliquely forwards through the cheek into the mouth, betwixt my two fingers; then drawing back the awl, I passed an eyed flexible probe, mounted with a small cord of silk, through the passage made by the awl, and brought it out between his lips with my fingers, leaving one half of the cord hanging from the external ulcer: then the ends of the seton, being disengaged from the probe, were tied loosely near the angle of the mouth; and his external ulcer was dressed up with dry lint kept on with a plaster. He was desired to rinse that side of his mouth frequently with brandy; and the sides of the external ulcer were kept from growing out too fast, or turning callous, with the lunar caustic. In less than three weeks, this management had the desired effect of rendering the passage, in which the cord was engaged, callous, (which the looseness of the cord, and the want of pain when it was drawn, plainly showed;) when Mr Jamieson took out the cord, and cured up the external ulcer very soon. In a little time after, I saw our patient here in Edinburgh, with a firm cicatrice on the part where the sore had been.

This operation is plainly directed by my friend Mr Cheselden in these words (a): "When this duct is divided by an external wound, the saliva will flow out on the cheek, unless a convenient perforation be made into the mouth, and then the external wound may be healed."

(a) Anatomy, book iii. chap. 3.

N^o 29.

A N

E S S A Y

O N T H E

DISEASES of the LACRYMAL CANALS.

THE many improvements that have been made of late in most chyrurgical operations, as they shew how imperfect surgery was formerly, so they should be an incitement for endeavouring to improve it still further: which will be found no difficult task to any who carefully considers the natural structure and situation of the parts that are affected in the several external diseases; who examines the changes which these diseases do, or may, make on the body; who from thence lays down reasonable intentions of cure, whereby the parts may be brought as near to a natural state as possible, or the functions of such as are disordered or destroyed may be supplied by art; and lastly, who diligently weighs the manner, immediate effects, and consequences of every step to be taken in executing these intentions. I shall endeavour to shew, in the following remarks on the *fistula lacrymalis*, how far the want of due attention to these necessary circumstances is capable of keeping us in ignorance, and leading us into error. I made choice of the *fistula lacrymalis* for an example, because it is a common enough disease, that has been often seen and treated by surgeons, is wrote of in all the systems of surgery and in most collections of observations, and is more particularly examined by the professed oculists; yet, in my opinion, is very little understood, and has very defective or faulty rules laid down for its cure.

Without troubling the reader with critical observations on the old distinction.

inction of anchylops and ægylops, or on the impropriety of reckoning all ægylopes or ulcers of the internal canthus of the eye to be *fistulæ lacrymales*, or on the characters of any ulcer necessary to constitute a fistula; I shall only inform him, that the disease I now treat of, is such an indispotion of the canals that convey the tears from the eye to the nose, as does not allow the tears to pass as they ought.

The lacrymal canals, whose diseases are the subject of this essay, have been described by several anatomists; but, none of them having these diseases in view, their words or pictures will not probably give the reader an idea of these parts suited to my purpose: wherefore I shall give a short description of them, illustrated by figures, before I enter upon any account of their diseases.

The two lacrymal points, A, B, (Plate III. fig. 6.) situated each on a little prominence near the internal extremity of the edge of each palpebra, take in the tears to be conveyed by two little ducts of about four tenths of an inch long, which are continued from the points inwards and somewhat downwards, (the superior being the longest and most oblique), till they open into the lacrymal sac, D. Between the points and the angle where the palpebræ join, the *caruncula lacrymalis*, C, is placed. The lacrymal sac, D, lies upon the groove formed partly in the nasal process of the maxillary bone, and partly in the anterior half of the *os unguis*, to which its back-part adheres slightly; but this membranous bag is connected firmly to the ridge which is raised on the *os unguis*, at the posterior part of the groove, serving at this place as a proper distinguishing boundary between the orbit and exterior parts; so that the lacrymal half of the *os unguis* is without the orbit, while its posterior half constitutes a share of the bony sides of that cavity. Such another firm connection of the lacrymal sac to the bones is also to be observed at the fore-part of the groove, where a small future joins the *os unguis* to the nasal process of the maxillary bone.

The lacrymal groove of the *os unguis*, D, is about two tenths of an inch broad in its middle widest part, and is about half an inch long from the top, till it is covered by the maxillary bone, and a complete bony canal is formed for inclosing the whole lacrymal duct; which, after a short progress, opens into the nose immediately below the middle of the supe-

rior edge of the lower *os spongiosum*, where its extremity becomes smaller than any other part of it.

When we view the side of the nose after the bones have been divided by a perpendicular section, we see the *ossa spongiosa*, K, L, (fig. 7.) situated near horizontally, depending by their superior edge from the other bones, and removing farther from them as they descend. The anterior extremity of the superior *os spongiosum* K, is fixed to the other bones very near where the upper part of the *os unguis* is joined to the frontal bone; and the superior edge of the inferior, L, is very little below where the great lacrymal duct begins.

This short description will, I hope, assist the reader to understand the several morbid cases I am now to consider.

If, after any erosion of the eye-lids, the lacrymal points, or the small pipes going from them to the lacrymal sac, are entirely blocked up by their sides growing together, which may be known by the constant weeping of the affected eye, after a disease capable of producing such an erosion, without any tumour, but on the contrary with a depression of the teguments covering the lacrymal sac, and by the points being so obliterated, that one of Anel's small probes cannot be pushed by them into the sac; in such a case, I say, the patient must all his life bear the deformity and uneasiness of a weeping eye, or some such operation as the following must be attempted: Let the lacrymal sac be opened in a slow cautious dissecting manner; after which push a small round curve needle with a waxed thread from one of the prominencies of the palpebræ, where the lacrymal point naturally is, into the superior part of the sac; draw out the needle at the aperture lately made, and leave the thread by way of a seton; do the same at the part where the other *punctum lacrymale* was. Soon after the small inflammation these threads may raise is over, the briny tears trickling along them will make the passages callous, and fit for supplying the office of the natural ducts when the threads are to be taken out; and the aperture in the sac, which has been kept open by dossilis, and refreshing sometimes with the lunar caustic, will very readily shut up as soon as this manner of dressing is forbore, and that it is only covered with a pledgit. The success with which an artificial passage, formed
this

this way into the mouth has supplied the salivary duct *, may make us judge, that the method just now proposed might also be successful.

When the fibres of the lacrymal sac are too weak, or the large duct is obstructed by some concreted liquors, the sac is gradually stretched by the tears which regurgitate frequently at the *puncta lacrymalia*. Some call this disease a *dropfy*, others would have named it a *hernia*, of the lacrymal sac. We know it by the tumour of the sac, without hardness, discolouring, or pain, which disappears as soon as we press out the tears at the *puncta lacrymalia*. While this disease is recent, these tears are pure; afterwards some pus appears with them, because of the excoriation which the sac suffers. Lest there should be any hazard of mistaking a tumour or small abscess in the teguments, which cover the lacrymal sac, for the disease of the sac just now described, as I have seen done, allow me to mention, that such tumour is easily distinguished from the hernia or dropfy, by its not diminishing or not discharging a large quantity of tears or pus at the *puncta lacrymalia* upon pressure.

The method of cure in the dropfy, is to pass one of Anel's probes from the *puncta lacrymalia* into the nose, to remove any grumous matter that may be lodged in the lacrymal canals; and then to inject, by the lacrymal points, mild, detergent, and gently astringent liquors, such as melrose diluted in lime-water, to which a little brandy may afterwards be added, or any chalybeate water, or a little weak wine, &c.: which injection is to be repeated twice or thrice a-day; and in the intervals the cure is assisted by external compression, made with compress and bandage, or the proper compressing machine, and by corroborants. We read of several cures performed in this manner by Mr Anel and Mr Heister; I have also had success with it.

It will be necessary here to observe, that the small duct, going from the superior lacrymal point A, (fig. 6.), being more oblique than the inferior, it will be more proper for passing the probe by; and, because the passage from that point into the nose is not straight, the probe must be bended into a small arch of a large circle. The superior eye-lid being then raised, and its edge turned a little outwards with the fingers of one hand, the surgeon, resting the other hand on the patient's cheek near the exterior

* See the preceding article.

exterior canthus of the eye, introduces the probe, with its convexity upwards, into the punctum; and raising his hand gradually as he pushes the probe forward, he brings it almost perpendicular to the lacrymal sac, by the time that the probe reaches the lower part of that sac; then he turns the probe softly, till he brings its concavity towards the nose; and pushes it downwards through the great duct into the nose. After which he moves it up and down, and to different sides, to break any concremented matter lodged in it.

The inferior *punctum lacrymale*, B, will be fitter for introducing the pipe of the small syringe into, and for making the injections by; because the inferior eye-lid has not near so much motion as the superior, and is more easily held with its edge turned a little outwards, at the same time that the surgeon has a better rest on the patient's cheek for the hand that holds the syringe, than he can have in making the injection by the superior point.

A proposal has been lately made to introduce a small pipe at the lower part of the lacrymal duct, into the sac, by which medicines may be conveyed for curing several diseases of the lacrymal canals; but I don't know whether cures have been made with this pipe.

If these methods of injecting and compression are not successful, and the internal part of the lacrymal sac is become spongy and ulcerated, which we judge to be the case by the quantity of pus expressed with the tears, the sac must be opened by an incision. When the sac is much distended, and the matter in it is thick, it is as easily opened as any common abscess: but, when the swelling is little, and the matter is thin, I have observed, that, notwithstanding the skin was kept as tense as I could betwixt my thumb and two fingers, and an assistant endeavoured all he could by pressure on the *puncta lacrymalia* to prevent the tears and pus escaping by these orifices; I say, notwithstanding these precautions, I observed that the pressure of my knife squeezed out the liquors contained in the sac, and made it collapse so much that it could not be opened without a manifest risk of cutting the posterior side of the sac, and so laying the bone bare, which evidently appears necessary to be shunned in the case I now speak of. When the sac is full of spongy flesh, or has contracted after an unsuccessful attempt of the operation, it is scarce possible to
know

know when the sac is opened, or how much of it is opened, by an incision, without having some directory for the knife. To avoid these inconveniences, in such cases, I introduced a small probe at one of the *puncta lacrymalia*, and caused an assistant to raise up the sac with it, while with a gently-crooked sharp-pointed bistory, I cut the stretched teguments in the common way, till I felt or perceived the naked probe; when, laying aside the bistory, and taking a pair of crooked scissars, I introduced the probe-pointed blade into the sac, and cut it first upwards, and then downwards, till its whole length was opened.

In making this opening, the tendon of the orbicular muscle of the eyelid must be cut through; but it is of no consequence, for the firm cicatrice afterwards ties that muscle to the bones here sufficiently to prevent any inconvenience. We are however to take particular care not to cut so near to the joining of the palpebræ, as to be in any hazard of dividing them, which might occasion a considerable deformity: and it will be more convenient to save the angular artery and vein, than to wound them; because, if they are wounded, the blood which they pour out hinders the operator to see so distinctly what he is doing.

After the sac is fully opened, we can observe in what condition it is, and are at liberty to free the nasal duct of any thickened matter that happens to be in it. Small dossils, armed with some proper medicines, either of the detergent, drying, or strengthening kind (according to the morbid state of the sac), are laid into the sac, but without being very hard, or being stuffed strongly in, lest unnecessary pain and inflammation should be occasioned. The lips are then covered with a small pledgit, and this is kept on by a semilunar snip of adhesive plaster; and, if the dressings do not keep well enough in the sac, compresses, and the compressing instrument, should be put upon them. While the disease is curing by proper medicines, the lips are kept fresh with the lunar caustic. When once the sac is made sound, the orifice in the teguments closes very soon after the use of the dossils is forbore, if the patient is in any thing of a tolerable habit of body. I have practised this method with success.

When the large *lacrymal duct* is excoriated, or has fungous flesh rising from it, which will be known by the acute pain, or great insensibility, and by the difficulty of passing a probe through it after the sac is opened,
and

and by a view of its superior part, there is a necessity of dropping or injecting proper medicines into it, and of keeping its sides from becoming contiguous by introducing some convenient substance into it. When medicines are made to pass through it, the patient must be desired to hold his head forwards, that the liquors may run out at his nose, instead of falling back into his fauces. In my opinion, a small tent of lint, secured with a thread, and armed with medicines, is preferable to a small wax bougie, or any thing that is oily, because these keep the parts raw much longer, and do not imbibe suitable medicines. As soon as the duct is brought to a right condition, the disease is the same as in the preceding supposition.

Let us now suppose, that the fungous flesh rising from the sides of the duct has united and blocked up the passage entirely, which can only be discovered after the sac is open, by the impossibility of introducing a probe, or making liquors pass through it, into the nose, while it feels soft and yielding, without that sort of firm resistance which a bone covered with a membrane makes, and which cannot be described well in words, but what all surgeons of any practice know. In the case as I have now put it, I think there is still no necessity of hurting the bones in order to make a passage for the tears. What I would propose is, to push a small shoemaker's awl, or some such instrument, through the middle of the fungus into the nose; and then to keep this artificial passage open, and to render it callous by a tent or seton. In making the perforation, the instrument must be held with its concavity towards the nose; and it must be thrust through slowly, and with no great force, the surgeon changing its direction a little whenever he touches the bone with its point: when the drops of blood coming out of the nose, shew the instrument to have perforated far enough, it is drawn back, and the tent or seton must be immediately passed in the same way. The seton is preferable, in my opinion, but requires the probe by which it is introduced to be of very flexible silver, and previously brought to a particular form. Fig. 8. is a probe about three inches long, bended into a semicircle, only with near half an inch toward the point pretty straight: this I have made to pass from the lacrymal sac into the nose, and brought it out at the nostrils, of several dead bodies, without using force, or changing its form. The
small

small cord that is brought through in the eye of this probe, is to remain for some days, without shifting the part engaged in the duct, till it becomes loose by the suppuration which happens round it; then it may be drawn a little, having besmeared the part that is to be next introduced with some gentle suppurative balsam. In a very little time, the suppuration will waste as much as is sufficient; and then the detergents and desiccatives will succeed in bringing the canal near to the natural state. I need scarce mention the tying of the two ends of the cord after each dressing, to keep them from hanging over the face, whereby they would be in hazard of being unwarily pulled; or the necessity of dressing the fac all the while, as in the former supposition; or taking out the cord and curing all up, after the duct and fac are found, they are so obvious.

If the duct has been blocked up in a child, and no cure is attempted till the person comes of age, the duct may be so obliterated or small, that the method now proposed cannot be executed, and an artificial passage must necessarily be made through the bone. But as this case can never be certainly discovered till the fac is opened, we ought still to proceed in the cautious way I formerly mentioned for this part of the operation. The place of the *os unguis* where this perforation ought to be made, will easily be determined from the description I gave of the parts, and from the advantage of the canal for the tears being at the most depending part of the fac. It must not, however, be attempted to be made where the natural duct was; for, in piercing the bones in that place, and with that direction, the instrument will more readily pierce into the large *sinus maxillaris* than into the nose. If the perforation is attempted to be made too far outwards, the instrument must be forced through the maxillary bone, which cannot be pierced but with great difficulty. I imagine any one may easily understand the place and direction for making the perforation right, by observing how the two pins are placed in fig. 6. and how they come through the *ossa spongiosa* in fig. 7. at M and N; for the pin E in fig. 6. being thrust perpendicularly through the *os unguis*, about the middle of the lacrymal fac, pierces the anterior extremity of the upper *os spongiosum* at M, in fig. 7.; and the pin F in fig. 6. thrust very obliquely through the *os unguis*, at the lowest part of the fac, pierces the *os spongiosum inferius* at N, in fig. 7. The pin F, placed so far back as to be con-

tiguous to the ridge dividing the *os unguis* with the perpendicular direction of the other pin E, would answer all intentions without any risk.

The instruments with which this perforation has hitherto been ordered to be made, appear to me very faulty. One general fault to all of them is, their destroying more of the *os unguis* than is necessary or safe: for wherever the orbital part of it is diseased, there is great danger of an inflammation and suppuration being brought on the muscles and fat within the orbit; which may be attended with a train of troublesome dangerous symptoms, that art can do little to relieve, because of the quantity of fat, in which pus diffuses itself easily, and cannot be restrained by medicines or compression in such a cavity as the orbit, and in the neighbourhood of such a sensible moveable necessary organ as the eye. The actual cautery gives great pain, burns the neighbouring parts, raises inflammation, and leaves a carious piece of bone to exfoliate; which retards the cure much. The directory, or blunt stilet, when pushed through the bone, fractures it far and near, and often rushes into the nose so far as to break the *septum narium*. The olive-shaped blunt perforative, or the tapering strong forceps, make large fractures in the bone, besides opening a passage large enough to let the point of one's finger pass, where one no larger than a crow-quill is required. In place of all these, then, I would propose always to make use of a drill, small perforative of a trepan, gimblet, trocar, or any such small instrument that can perforate with little force and no fracture. The trocar is the instrument I have made this perforation with several years past, in the following manner. Choosing a trocar, the stilet of which is of the size I wish to have the perforation, and is as much longer than its canula as I think necessary for perforating into the nose, I put a probe into the canula, to search for the lowest part of the ridge of the *os unguis*; at the fore-part of which I keep the probe till the canula is pressed softly down to that part of the bone. When the probe is taken out, the canula is put in the proper direction, and the stilet of the trocar is then put through the canula, to be worked with half-turns of the hand till it perforates into the nose; in doing which its own weight is sufficient, scarce any pressure of the hand being required.

So soon as the perforation is made, withdraw the stilet, to pass a tent.
secured.

secured with a thread, or a piece of wire-drawn lead, through the canula into the nose; then taking away the canula, accommodate the tent or lead to the rest of the wound; or the canula may be taken away with the stilett after the perforation, and the tent or lead, or a little pipe, may be put into the hole, having the head of the tent broad, or the lead split a little at its outer end, that each part may be bended down to make a head, and the pipe should have little shoulders to prevent it from falling into the nose: then dress the lacrymal sac in the same way as was proposed above, when we supposed the sac to be laid open. Allow these dressings to remain till the suppuration comes on, when they are to be renewed. Whenever the inflammation is gone, by drying medicines injected at the new orifice, or conveyed into it by the tent, endeavour to harden the membrane with which the thin edges of the perforated bone soon cover. I used melrose and a little brandy, increasing gradually the proportion of this last medicine. Whenever the tent can be made to pass this hole, without giving pain, leave off the use of the tent or pipe, and cure up the external orifice as soon as it will go together; which is very soon, if its lips have been gently touched from time to time with the lunar caustic. In this way I have cured those who had this disease from their infancy, without one bit of bone exfoliating, or the least weeping in the eye afterwards, or other inconvenience, not so much as an observable scar.

I am informed, that a gold pipe has sometimes been left in the new passage; the cut fore-part of the sac having united while it remained there.

Let us now suppose, that the sharp matter in the lacrymal sac has destroyed its membrane, and rendered the *os unguis* on which it lies carious; or that the caries having begun in the bone, the ichor of it has eroded the membrane. In this case, if there is a large passage eroded also through the *membrana narium*, while the teguments are whole, it may be long before the lacrymal canals can be discovered to be affected; and the disease will be treated as an ozæna. But if there is no such passage into the nose, the malady may be known by the brown-coloured stinking ichor diluted with tears; which may be squeezed out at the lacrymal points, upon pressing the lacrymal sac.

The method of cure here will be to open the lacrymal sac, as in the former cases mentioned; to separate as much of the bone as is carious;

to make a perforation with the point of a lancet or bistory, through the *membrana narium*; and then to complete the cure as directed in the preceding supposition of the bone being artificially perforated.

The separation of the carious bone is ordered to be hastened by the application of the actual cautery, tinctures of myrrh and aloes, and of euphorbium: but, in my opinion, the breaking away with a pair of forceps all that is carious, will be much more speedy, and is not attended with such inconveniencies as the other methods are.

It must have been observed, that I have hitherto supposed the diseases of the lacrymal canals to be attended with no opening of the teguments made by erosion, nor with any maladies of the neighbouring parts; and I believe, it will be seen, there is no necessity of insisting at any length upon them: for when there is an opening in the teguments, near the internal canthus of the eye, we can easily discover whether the lacrymal canals are affected, by pressing pus out of the *puncta lacrymalia* before the ulcer is cleaned; and after the pus is wiped away, the tears will run out at the external orifice; which also gives a better opportunity of introducing instruments to discover the state of the diseased parts.

In the cure, there is nothing different from what has been formerly directed, unless that the opening into the sac is more easily made, where the external orifice is large enough to allow the necessary instruments to be introduced; and when it is too small for this purpose, we must enlarge it, by putting into it tents of sponge made firm and hard, by being soaked in some melted plaster, and then kept pressed under a weight, or in a press, till the plaster hardens: or this sponge-tent may be prepared, by simply wetting the sponge in water, or a diluted mucilage or glue; and then rolling pack-thread firmly round it, and hanging it up thus till it dry.

There is such a great variety of diseases which may accompany these maladies of the lacrymal canals, whether as causes, consequences, or accidental attendants, that it would be to engage in almost a system of physic and surgery to give a detail of them: and therefore I shall pass them without any further examination.

Fig. 1.

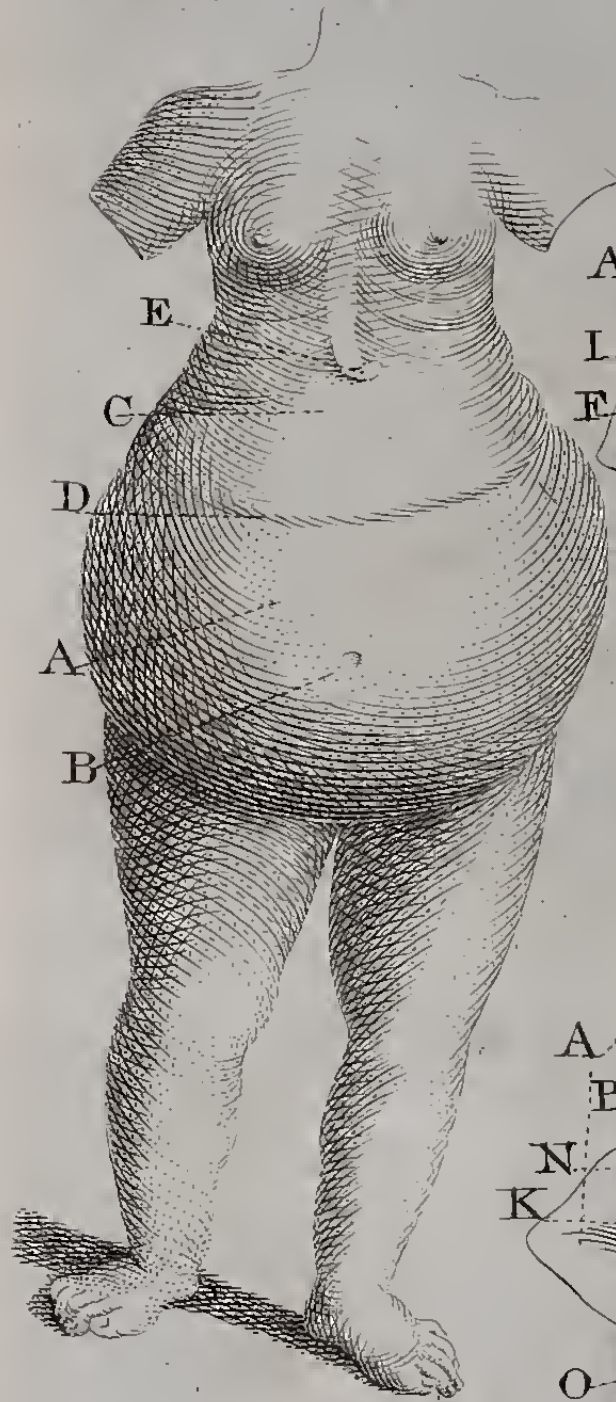


Fig. 2.

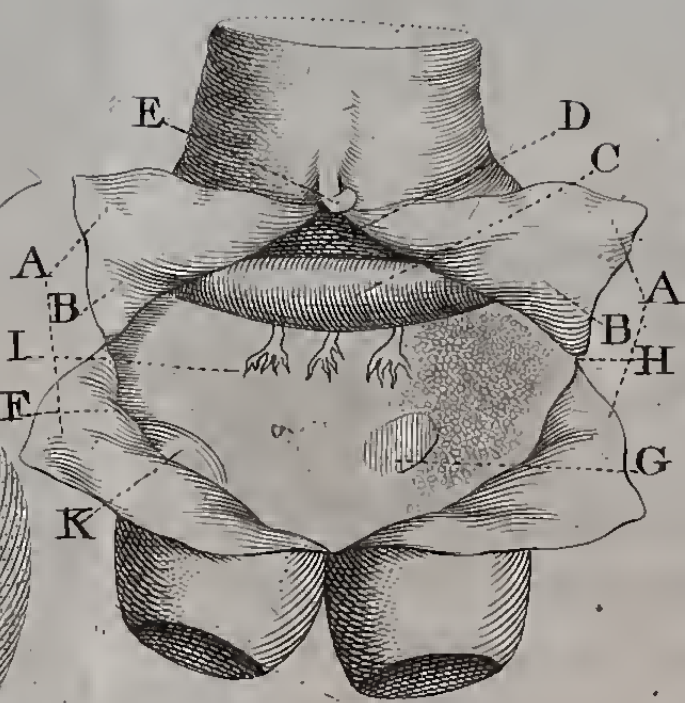


Fig. 3.

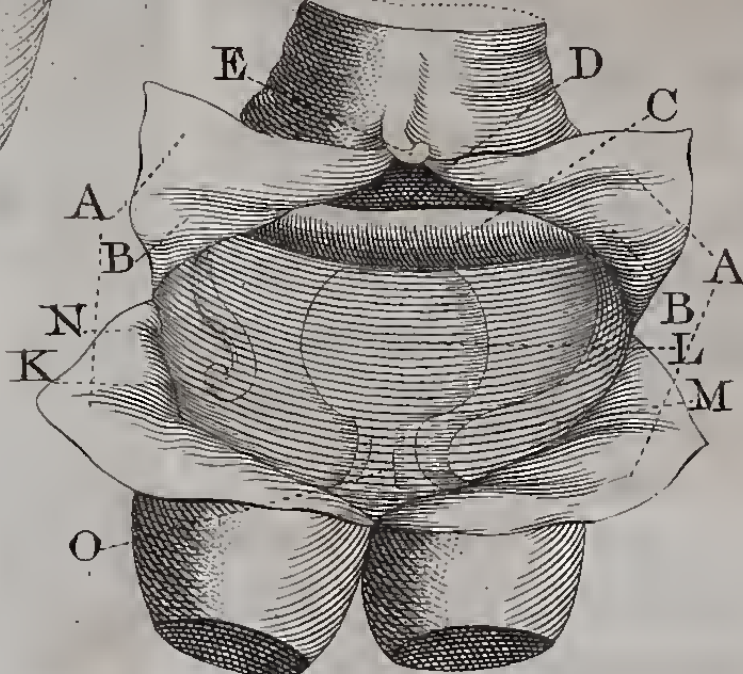


Fig. 4.

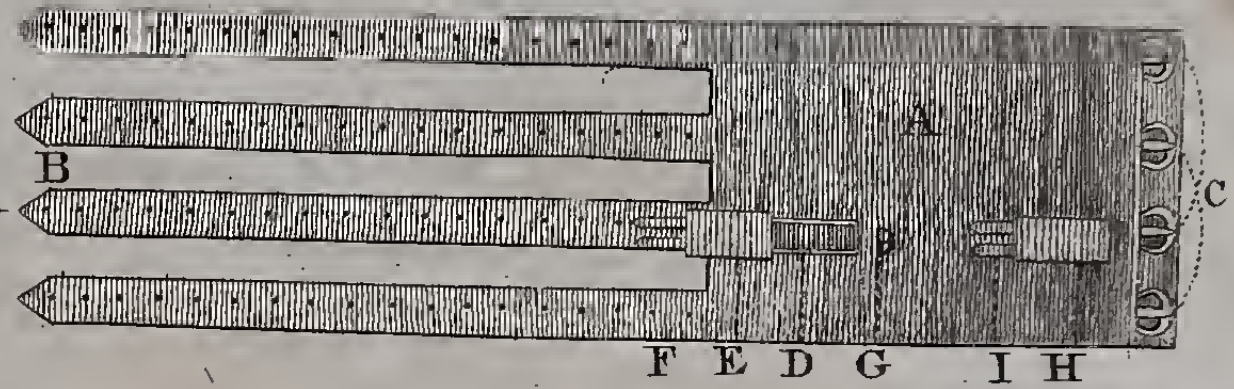


Fig. 5.

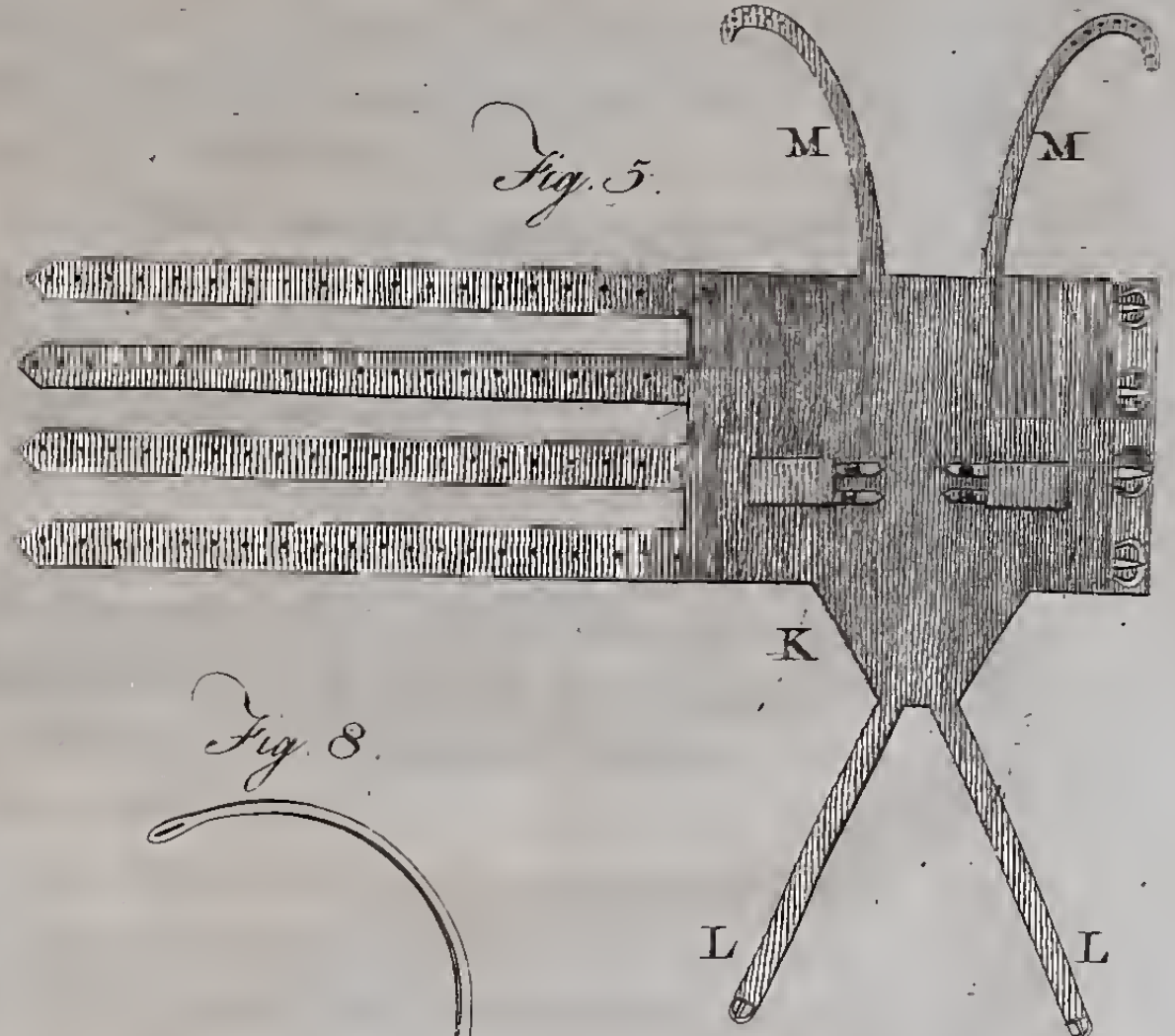


Fig. 8.

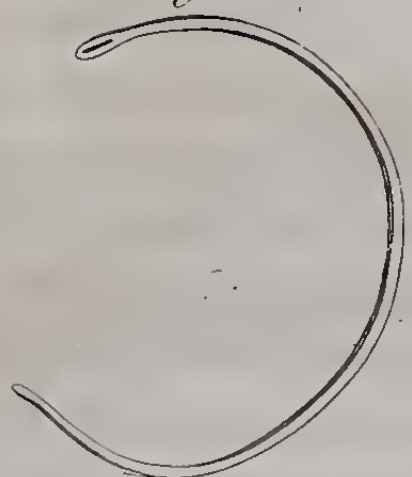


Fig. 6.

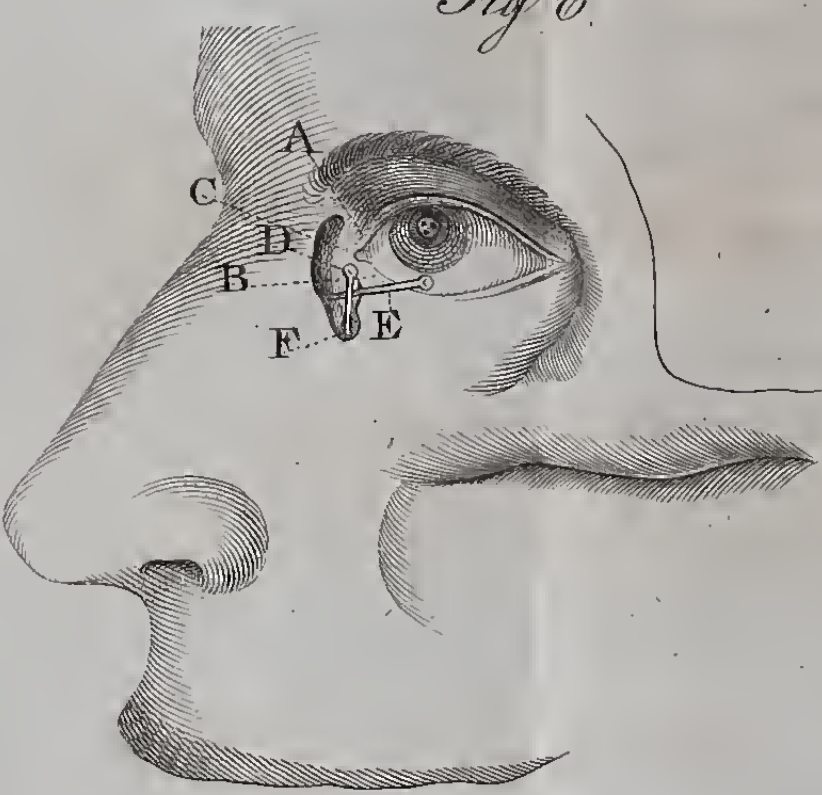


Fig. 7.





A TUMOUR of the NOSE unsuccessfully extirpated.

A CHILD was born with a small moveable tumour on its nose, which increased as the child grew; otherwise the child was healthy and strong, having only had a short fever or two, and passed some worms, before five years of age, when my advice was first asked concerning that tumour. It was then so large as to cover all the nose, except the nostrils; and was so prominent to each side, that the eyes were in part covered with it. Towards the base, it was so soft, that, by pressing a finger on each side, they felt each other; but, at the most prominent part, there were several hard round knots. When I saw it, the child complained of no pain; though I was informed that sharp lancinating pains sometimes struck through the tumour. I held the nostrils, while the child forced its breath that way; but saw not the tumour rise any. I searched into the nostrils with a probe; but could neither feel any excrescence, nor push the tumour or teguments outwards. The *os frontis* was firm, and united in the middle. From all which I concluded the bones of the nose to be complete; and therefore was of opinion, the tumour (which would make the patient very miserable by increasing, and would bring death at last) might be safely extirpated. Being, however, taught by Job à Meekren*, and some others, how deceitful excrescences of the head, brought to the world with a child, might possibly be, I would not undertake the cure, till another surgeon, of more experience and longer standing, in my neighbourhood, who justly has a considerable character, should examine the tumour, and assist me in whatever was determined to be done. That gentleman joining in opinion with me, I undertook the extirpation with his assistance. When I had dissected about half the base of the tumour off, I observed the bones of the nose to be incomplete; and that the mem-

brane,

* Observ. cap. 7.

brane of the nose, part of which I had laid bare, was moved outwards in expiration, and inwards in inspiration. Not being certain how far upwards the bones might be wanting, I dissected all the tumour off at the lower part, but left a little of its base above. Having stopped the bleeding, I dressed the wound in the common way.

When the tumour was examined, it appeared all of a substance little firmer than the common fat under the skin; except where the knots were, which were of a scirrhus hardness.

The child passed the first night pretty easily. Next morning the pulse was a little quick, attended with a thirst, and a sickness at the stomach, which had made the patient vomit once. An emollient clyster being injected, and emulsion given for drink, these symptoms abated. Towards the evening the dressings seemed moister than they commonly are so soon after a wound.

In the morning of the second day after the operation, the dressings, child's hair, and head-cloaths, and the pillow under its head, were all wet with a watery liquor; which had a particular smell that I never felt in any wound before, and do not know how to describe. The dressings being taken off, we saw that this liquor oozed fast from the bared membrane of the nose, though we could not perceive the orifice by which it escaped. We applied from time to time *Bol. Armen. Pulv. Helvet.* chalk, sugar of lead, white vitriol, burnt alum, blue vitriol, quick-lime, brandy, alcohol, oil of turpentine, spirit of nitre dulcified, plain spirit of nitre, oil of vitriol, lunar caustic, the actual cautery. In short, we applied every thing we could think of that had any chance for stopping this oozing of lymph, but without success. On the sixth day, our patient vomited a long round worm; in some time after fell into convulsions, and in an hour more died.

An Account of a PROCIDENTIA UTERI.

IN the month of August 1728, — Scobie being seized with a fever, which continued some days, when she was not full three years old, had a considerable discharge of blood by the vagina for three days: after which she seemed to be in perfect good health about twenty days; then complained of pains in her belly, loins, and thighs, and had such another evacuation. The quantity of blood voided, was judged by her mother to be as large as what she herself commonly had in her menses. The child suffered regularly such returns every three weeks, or, at furthest, within the month, attended with the same symptoms, without any considerable loss of strength, or decay of her body, till the month of May 1729. But during the third monthly evacuation, which was at the end of September 1728, her mother observed a small swelling rising out from the orifice of the vagina; which disappeared as soon as the hæmorrhage ceased. This tumour, however, came out larger at each period thereafter; but upon the child's being kept in bed three or four days, and the flux of blood stopping, always disappeared, till May, that it came out of a considerable bulk, and did not return as usual. From this time there were no more periodical evacuations of blood: but, instead of these, there was a perpetual dropping of a white mucus from a hole in the lower part of the tumour; which mucus was sometimes in so large quantities, that if a swath had been applied some hours about it, to prevent that liquor from coming away in drops, as frequently was done, whenever the swath was taken off, the mucus was thrown out so abundantly, and with such force, as made those present to imagine it was urine which the child passed.

About the end of July, the parents having brought the child to the hall of the college of physicians, where Dr John Riddle and Dr William Porterfield

terfield were then attending to give advice to the poor; these two gentlemen having viewed the child, desired the parents to carry her to me.

Being informed of the preceding history by the child's mother, I examined the parts, and found a tumour G, (see Pl. IV. fig. 1.) hanging out at the vagina, as big as a hand-ball, the neck of which, F, was about an inch diameter. At the lowest part, H, the tumour was largest, and of a faint leadish colour. Behind the most prominent part of it, I discovered a hole of one-fourth of an inch diameter, by which I introduced a probe, I, some inches; and then the probe was resisted, and the child complained of pain. From this hole there was a constant stillicidium of mucus. Round this orifice the tumour felt hard and firm: but a little higher, where it was largest, it was softer, seeming to be composed of a cellular substance; at this place scales had frequently formed and fallen off. The neck, F, of the tumour was very smooth, of a shining red colour, and very solid and hard; I introduced a probe betwixt this neck and the sides of the vagina, two inches upwards, and turned it all round the circumference of the neck. The clitoris D, nymphæ B B, and orifice of the urethra E, were natural enough: only the neck of the tumour pressing on the urethra, occasioned some difficulty in the excretion of urine; and the urine being diffused over the *labia magna* A A, and other neighbouring parts, had, by striking against the large base of the tumour, somewhat excoriated these parts.

The child could scarce sit, and straddled when she walked; but lying a-bed she was very easy. Her complexion was pale; and her body small; otherwise she was healthy. Having consulted with the two gentlemen who had sent her to me, and several other physicians having seen her, the disease was unanimously judged to be a *procidentia uteri*. Wherefore I attempted to reduce it; but the tumour was so large and firm, I could not accomplish it. Fomentations and cataplasms, first of the emollient and discutient kind, were applied; afterwards they were formed entirely of the attenuants; and lastly astringents were tried. In the mean time the child underwent the general evacuations as much as her strength could bear, without the tumour's yielding in the least, but, on the contrary, daily increasing; at last she began to turn hectic, and the tumour to be disposed to gangrene on its outer surface, which were in vain endeavoured

to be prevented by diet and antiseptic medicines. I several times considered of the amputation; but, being sensible of the body of the uterus being to be cut through, and frightened by the ill success Ruysch and some others had in this operation, I had not courage enough to undertake it. The child in the mean time turned weaker; the tumour gangrened in its external surface; and, by the gangrened parts falling off, it was reduced to near half its former bulk. Ten days after which, (7th November), she died.

On opening the abdomen next day, the bladder, K, was full of urine: the left ureter, M, was in a natural state; but the right one, N, was distended, by urine, to four times its natural diameter; and the kidney from which it came was larger, softer, and paler than the other, but without any appearance of the folliculi or vesicles sometimes found in morbid kidneys. The urine had certainly been retained in the bladder by the neck of the preternatural procidentia pressing on the urethra; and the distension of the right ureter was owing to a steatomatous body, U, some more than an inch long and seven tenths of an inch broad, which lay behind the ovarium and *ligamentum latum*, and reached to the cervix of the bladder, to which it firmly adhered, and through its exterior extremity the ureter passed.

There was scarce any thing of the uterus to be seen, till the bladder was reclined over to one side; when a small part of its fundus, O, appeared.

The *tubæ Fallopiæ* Q Q were nearly perpendicular to the uterus, and the ovaria T T were situated contiguous to them.

Having made these remarks, and carefully observed the situation in which the several parts were, I dissected off the peritonæum and its cellular membrane from the bones and muscles composing the sides of the pelvis, and brought away all the parts contained in that cavity with the right kidney and ureter: and then, that a view of the whole might be had in one figure, I dissected the left side of the bladder away from the peritonæum, and reclined it over to the right; after which, having with a needle passed threads through the skin where the *mons veneris* and external or great *labia pudendorum* are, I gently stretched the skin of these parts, and secured it in that posture by help of the threads which were tied to a

probe, and two pins which I had made fast to the table; in which posture the engraver delineated it, having his view obliquely from the left side and from above. The figure he drew, and afterwards graved, will, I believe, better explain the situation and connection of all the parts, than any description; and is the only one I know that gives a distinct idea of this disease my patient laboured under, a genuine *procidentia uteri* covered with the vagina, and without any inversion of the womb.

AA The two great *labia pudendorum*.

BB The *nymphæ*.

C *Præputium clitoridis*.

D *Glans clitoridis*.

E The orifice of the urethra.

F The neck of the *procidentia* as it came out at the vagina.

G The left side of the tumour, which was much diminished by the falling off of the gangrenous parts.

H The right side, which had no parts cast off.

I A probe put into the uterus by its internal orifice.

K The bladder distended with urine, and reclined over to the right side.

LL The jagged edges of the peritonæum both on the left side of the bladder, and of the pelvis where it was cut, to remove the bladder to a side.

M The left ureter of the natural size.

N The right ureter greatly enlarged with urine.

O The *fundus uteri*.

PP The *ligamenta lata*.

QQ The *tubæ Fallopianæ*.

R The *fimbriæ* of the right *tuba* with its orifice in view.

S The left *morfus diaboli* seen on the side averse to the orifice.

TT The *ovaria*.

U The extremity of the steatom appearing from under the right ovary.

W. The thick *tunica cellulosa* at the side and back-part of the pelvis.

X The *intestinum rectum*.

Y The probe to which the thread supporting the *mons veneris* was tied.

ZZ The

ZZ The pins to which the threads stretching the great labia were fastened.

After the figure was drawn, I endeavoured to discover, by dissection, how far the inverted vagina or uterus had each been increased in their bulk to form such a large tumour; but they were so intimately united, that I could not distinguish the one from that of the other, and therefore could not determine their proportional thickness.

The URETERS obstructed by small STONES.

AN old man who had suffered under some severe fits of the stone, several small ones of which he had passed, and who afterwards had violent hæmorrhagies at his nose, recovered, in appearance, a very firm state of health, without any complaint, and enjoyed it a considerable time. Being attacked with another fit of the gravel, and nothing being evacuated from the bladder, except now and then a spoonful of a clear limpid liquor, which had neither smell nor taste of urine more than serum of the blood has, and no distension of the bladder coming on, was blooded, purged, bathed, and all the other methods practised in obstructions of urine and stone were employed in vain, the obstruction remained, he became comatous and died.

The left kidney was considerably less than natural, and was become a thin sac; the ureter belonging to it was very small, and felt hard. When cut open, it was found fully stuffed with a gravel of a dirty black colour, squeezed so close together that no liquor had probably passed that way for a considerable time.

The right kidney was distended with urine to a monstrous size; and the ureter was so large, that at first sight I mistook it for a piece of intestine. Upon opening it down to the bladder, I found a small stone niched so firmly between the coats of the bladder, that I had some difficulty to bring it out; it was not above a fourth of an inch from the orifice of the ureter into the bladder.

N^o 32. (B)

R E M A R K S

O N T H E

SPERMATIC VESSELS and SCROTUM, with its CONTENTS*.

BY the public advertisement which Valsalva gave (*a*) of having discovered ducts sent from the *glandulæ renales* to the testes of men and ovaria of women, we were made to hope for considerable assistance in accounting for generation and the use of the *glandulæ renales*. Valsalva dying without explaining fully the discovery he pretended to, Morgagni (*b*) related what he found in Valsalva's papers concerning this subject, of which you have given an abridgement (*c*); but have not remarked with Morgagni, that Valsalva had not seen what he thought to be a duct of those parts more than once in the human subject.

Soon after Valsalva's advertisement was published, Mr Ranby (*d*) described a branch of the artery of the *glandula renalis* sent down to the testes of men and ovaria of women, which he thought Valsalva might possibly have mistaken for an excretory duct. You also took notice of this (*e*), and begged Mr Ranby to determine, Whether such an artery was constantly or seldom found? Since your question has not been answered by the gentleman to whom it was put, the remarks I have made in dissecting the spermatic vessels of a considerable number of human subjects, may possibly not be disagreeable to you.

I. In

* Originally inserted in the Edin. Med. Essays, Vol. V. Art. xx.

(*a*) Giornali di literati, 1719. (*b*) Comment. Acad. Bononiens. p. 379.

(*c*) Medical Essays, Vol. II. Art 33. (*d*) Philos. Transact. Num. 387. § 3. Num. 395. § 12.

(*e*) Medical Essays, Vol. II. Art 33.

1. In the greater number of human bodies, the spermatic artery of each side rises from the anterior part of the aorta, between the emulgent and inferior mesenteric arteries, as they are painted by Eustachius (*a*); and having each its course obliquely downward and outwards, becomes, contiguous to its vein, a knotty membranous substance connecting them here more firmly together than any where else in their progress. The artery descending sends numerous small branches off to the cellular substance it is lodged in; and near to the ovarium in women, or some way above the testis in men, divides into two branches, as painted by Swammerdam (*b*) and De Graaf (*c*). The larger branch in men is bestowed on the testis, through the substance of which its numerous branches are dispersed every where, as may be evidently seen after a good injection. The lesser branch of the spermatic artery in men is principally lost in the epididymis, though I have frequently traced its very small branches dispersed also on the testicle.—The larger branch of the spermatic artery in women is sent to the ovarium, and to anastomose with the other uterine arteries; the lesser one is distributed to the *tuba Fallopiana* and *ligamentum latum*.

2. Numerous veins coming out of the testis and ovarium, unite and separate so often, as they ascend to be collected at last, with the many branches they receive from the parts they run near to, into one large vein, as to deserve the name of *corpus varicosum* or *pampiniforme*. The single vein into which these numerous smaller veins unite, empties itself into the *vena cava*, immediately below the emulgent on the right side, and into the emulgent vein on the left side.

3. Where the artery and vein are contiguous, the venous branches cross over and twist round the artery so, that at first view one would be in hazard of thinking they united into one canal, or opened by a large anastomosis into each other; but by dissecting carefully, and after an injection, one sees plainly there is no such anastomosis.

4. These vessels, while in the abdomen, are on the outside of the peritonæum in their whole course, lying in a cellular substance, over the anterior part of which the peritonæum is stretched.

5. Though the rise and course of the spermatic arteries are commonly
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(*a*) Tab. 12. and 13.

(*b*) Miracul. Natur. Tab. 1. 2. 3.

(*c*) De Organ. Gener. Tab. 1. 2. 12.

as I have just now described, yet frequently there is a variety to be observed here: for, in some bodies, I have seen one or both spermatics rise from the aorta higher or lower than the ordinary place; in others, I have found them coming from the emulgents, or from the arteries of the *glandulæ renales*; three bodies are all in which I found this origin of the spermatic arteries from the arteries of these glands, or *capsulæ atrabiles*, as they are called.

6. Instead of one spermatic artery, of each side, I have seen several times two in one of both sides, which had their origins in the uncertain way I mentioned the single artery to have.

7. When there has been one artery of a side, rising from the ordinary part of the aorta, I have seen it in one or both sides make an arch upwards before it turned down to the ordinary course. In one subject, a woman, the spermatic artery of the left side ascended from the aorta to pass between the emulgent vein and artery of the same side, and to make a large curve to come at the anterior part of the vein, over which it descended to go to the ordinary course.

8. I do not know if it is worth while to take notice, that I have more frequently met with those deviations from the ordinary structure, or those *lusus naturæ*, in the left than in the right side of the body.

9. Notwithstanding the differences of origin or course of the extraordinary arteries, they kept generally, in their further progress and distribution, to what I described as the ordinary rule; that is, the single arteries became contiguous to the vein near to the middle of the anterior surface of the psoas muscle, and afterwards divided into two branches to be distributed in the manner in which the branches of the spermatic artery commonly are distributed: and where there are two arteries on the same side of the body, they approach the vein in the ordinary place; the lesser one, which is commonly the one deviating most from the general rule, serving the epididymis or *tuba Fallopiana*; and the larger one being distributed to the testis or ovarium.

10. When the spermatic vessels of men are passing out of the abdomen, they insinuate themselves between muscular fibres; which may be said either to be part of the transverse, or of the internal oblique muscle of the abdomen, or of both. What occasions the difficulty in determining the muscle

muscle which these fibres belong to, is, that the course of the fibres of the two muscles is much the same here; and that the connection of the fibres to each other is so loose, by means of the cellular membranes, as to allow us to separate them as we please, by either leaving them with the transverse muscle, or raising them with the oblique, or giving a share of them to each muscle.

11. The spermatic vessels and *vas deferens*, in going through between the fibres now described, which form a passage that is very easily dilated, carry part of the cellular membrane, in which they lay behind the peritonæum, along with them, and acquire more from the cellular membranes of the muscular fibres.

12. Besides the muscular fibres between which the spermatics pass, there are others which, instead of continuing their course transversely from the *os ilium* to the *linea alba*, fall obliquely down on the outside of the cellular substance involving the vessels, and go out with them at the oval tendinous ring of the external oblique muscle, which is composed of firm interlaced fibres, and is not easily dilated.

13. In the passage between the muscles and through the ring, the spermatic cord obtains more cellular substance; and soon is immersed in the common *tunica cellularis* under the skin, to descend to the scrotum.

14. Frequently a slip of muscular fibres is sent off from the external oblique muscle of the abdomen, to join those which passed through the tendinous ring of this muscle, to assist in forming the cremaster muscle of the testis; which lying at first on the outside of the spermatic cord, gradually, as it descends into the scrotum, expands its fibres round the cord over the cellular substance, and at last is spread on the vaginal coat of the testicle, to which it adheres very firmly.

15. The cellular membranes on the inside of this muscle, where it covers the spermatic cord, lose their cellular appearance when cut, in the same way as is to be observed in what is called the proper membrane of most muscles; which, when stretched gently in dissecting the muscles, or by blowing air into it, evidently shows itself to be the same sort of cellular substance as is seen between the skin and muscles. The membranous appearance, however, which the cells within the cremaster muscle have when collapsed or stretched longitudinally, is what continues the opinion
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of their being a vaginal coat to the human spermatic cord; which was supposed for a long time to be a process or sheath sent down by the peritonæum in the human body, as well as it is in quadrupeds, which were then generally dissected. But the difference is very considerable: For, in men, the spermatic vessels lie entirely behind the peritonæum, and there is not any perforation or production from this membrane at the place where the vessels are passing between the fibres of the abdominal muscles; whereas, in many quadrupeds, there is a production of the peritonæum, which covers the spermatic vessels, but allows them to lie loose in the abdomen, analogous to what we see the mesentery does to the intestines; and when these pendulous vessels are joined by their pendulous *vas deferens*, they enter the orifice of a tube formed by the peritonæum, at the aperture of the abdominal muscles. This tube formed of the peritonæum, as the finger of a glove is produced from the glove, is continued down to the bottom of the scrotum, and contains the spermatic cord and testicle, which are only connected to it at the posterior part, where its membrane advances to furnish them their more immediate covering, which serves to keep them in a right situation, and to strengthen and protect them.

16. In our erect posture, where the moisture of the abdomen falls down to the lower part of its cavity, and where the bowels are always pressing with considerable force at the passage in the muscles, such a tube continued from the abdomen would have perpetually collected liquor in it, and made us much more subject to herniæ; of which there is less danger in quadrupeds, in whom this orifice of the tube is at the highest part of their bellies: but because, in straining contractions of their abdominal muscles, the viscera might be pushed out at this orifice, a moveable fatty flap is placed at the lower part of the orifice, which the bowels, pressed upwards, must carry before them to cover the passage to prevent their getting out, and at the same time to defend the spermatic vessels from the pressure of the bowels; which pressure, in our erect posture, we are much exposed to, and therefore stand greatly in need of, and are provided with a tense peritonæum to defend our spermatic vessels from it; notwithstanding which, the spermatic veins often become varicous when the belly is much stretched.

17. It may be worth while to remark here, that nature seems to attempt

a contrivance to prevent herniæ in men, a-kin to the fatty flap in brutes; whenever men are brought by diseases into the hazard of herniæ, from the orifice of a tube produced from the belly. After the reduction of herniæ, a fat substance has grown out from the peritonæum at the rings of the abdominal muscles, which prevented a relapse (*a*).

18. Some thought that the membranous bag, described and painted by Schrader (*b*) and Bidloo (*c*), from a preparation of Swammerdam's, coming out from the peritonæum along with the spermatic vessels, is a proof of the natural production of the peritonæum here; but as no such bag is for ordinary to be seen, and we know nothing of the circumstances of the person to whom this preparation belonged, while those who have dissected several people who had long wore trusses for herniæ tell us they found the remains of the sacs of the herniæ of the form which Schrader describes (*d*), it is reasonable to think Swammerdam's preparation was no other than such a morbid sac.

19. In place of one membranous vaginal coat from the peritonæum, some authors (*e*) have described three firm membranes investing the spermatic cord, which they say are aponeuroses from the muscles, through which the cord passes: but as these were only found in the dissection of unreduced herniæ, we may easily imagine how this appearance might be the effect of the morbid state of the parts, by the thickening of stretched cellular membranes, though there are no such firm membranes to be seen in a sound state.

20. The real structure of the human spermatic cord is, that the spermatic vessels and *vas deferens* carry along with them cellular membranes from the outside of the peritonæum, and acquire more as they descend; which are at first covered only on the external side by the cremaster muscle, and then are surrounded by it till they come down as far as the superior part of the testicle, when the cellular membranes terminate, and the thin fibres of the muscles are spread on the vaginal coat of the testicle;

as

(*a*) Pare, livre 18. chap. 15.

(*b*) Observ. dec. 2. obs. 5.

(*c*) Anat. Tab. xxxii. fig. 3. & 4.

(*d*) Le Dran, Observ. Chirurg. Reflexions sur l'observ. 58.

(*e*) Du Blegny Zodiac. Medico-gallic. an. 1. mens. Febr. obs. 1. Memoires de l'Acad. des Sciences, 1701.

as is to be seen evidently after putting a blow-pipe into the upper part of the spermatic cord, and blowing air into the cellular substance. Rau (*a*) has given us a pretty good picture of this.

21. In tracing the spermatic vessels accurately, we observe, that at the epididymis they pass between two contiguous membranes which can be separated: And if we continue the dissection of these membranes from each side of the testicle, we bring off a large membranous bag; the part of which that immediately invests and adheres to the testicle goes commonly by the name of the *tunica albuginea*, or *propria testis*; while the other part, being reflected down from the epididymis, forms the loose vaginal coat; and the part of it which covers the epididymis, and descends from that to where the cremaster muscle begins to be firmly fixed to it, is called by some late writers the *septum*, or partition between the spermatic cord and testicle; which may be considerably enlarged and thickened by diseases, and the addition of stretched cellular membranes adhering to the superior part of it.

In the same manner as is here proposed for bringing away the vaginal with the proper coat of the testicle in an empty bag, the membrane of the heart with the pericardium, or the pleura with the membrane of the lungs, or the peritonæum with the mesentery expanded over the intestines, and with the membranes of the other viscera over which it is spread, may also be taken out in so many empty bags; and therefore, in the strict way of speaking, none of these bowels can be said to be contained within the membranes that are commonly said to invest them.

22. Besides the artery which is named *spermatic*, there are two others which commonly are sent to each testicle. One is a branch of the artery which furnishes the *vesicula seminalis* and *prostatia* with blood, that runs upon the *vas deferens* as far as the epididymis; and sometimes I have traced its ramifications on the testicle after a good injection: De Graaf (*a*) represents some part of this artery. The other artery is sometimes sent down through the rings of the muscles from the epigastric: In other subjects, it comes out below the duplicate tendon of the external oblique muscle, that goes by so many different names of Vesalius's, Fallopius's, or Poupart's ligament, Douglas's arcade of the peritonæum, &c.; and, after

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(*a*) Respons. ad Ruysch, Tab. II. fig. 2.

(*b*) De Viror. Organ. Tab. VI. fig. 1. H.

after giving branches to the scrotum, enters the cellular substance of the spermatic cord, to go to the epididymis and testicle. Winflow (*a*) has mentioned this artery.

23. Some branches of veins coming away from the *corpus pampiniforme*, being joined with others from the scrotum, form a vein which accompanies the artery last described, to empty itself into the external iliac vein near to the ring of the external oblique muscle; it is generally considerably enlarged by veins returning the blood from the teguments of the lower part of the abdomen.

24. The oblong testicles are situated obliquely; so that their convex longest surface is anterior and inferior, while the epididymis fixed to the other side is superior and posterior; their extremity, where the thicker part or beginning of the epididymis is, being exterior and superior, and the *vas deferens* going out from the inferior posterior extremity.

25. The membrane connecting the epididymis to the testicle sinks into the root of the epididymis at the anterior part, and so leaves there a furrow between the testicle and epididymis; whereas, on the posterior part, the surface is smooth without any depression. By means, however, of the depression on the anterior part, the membranes of the two sides come very near each other, admitting the vessels only between them; which therefore run to the testicle at the posterior side of the epididymis (*b*).

26. The fibres or threads of which principally the testicle is composed, easily separate from each other; and a single thread can be drawn out to great length. These threads are probably vessels; but I cannot determine of what kind, never having made a coloured liquor to enter them.

27. The pellucid firmer fibres that run through the middle of the testicle from the convex side towards the epididymis, dividing it in some measure into equal portions (*c*), which are commonly esteemed excretory ducts, I believe to be blood-vessels, having forced a coloured liquor into several of them by injecting the spermatic artery.

28. The membranous substance under the epididymis (*d*), generally called Highmore's duct, has no cavity that ever I could perceive; which should certainly, however, be evident, if it was the common pipe for receiving

(*a*) Exposition des Arteres, § 237. (*b*) De Graaf, Tab. I. & II. (*c*) Id. Tab. IV. fig. 4.

(*d*) Highmore, Disquisit. Anat. Tab. XI. fig. 1. lit. g. g. De Graaf, Tab. IV. fig. 4.

ceiving the liquor from so many excretories as are said to open into it: It appears to be no more than the firm membranes connecting the testicle and epididymis together.

29. It has been doubted whether the *vas deferens* and epididymis were continued tubes or not. To be satisfied in this, cut the *vas deferens* through where it lies on the inside of the *vesicula seminalis*, and take it and the testicle away from the body: press the epididymis from its larger towards its smaller extremity, and from that to the cut end of the *vas deferens*, till you have squeezed out all the liquor you can; taking care, by squeezing with moist fingers, not to let these parts dry too much in doing this: then put up a long pipe into the *vas deferens*, and through it pour quicksilver: the weight of such a high column of mercury, assisted by your fingers pressing from time to time towards the testicle, will make the quicksilver go forward in the tortuous canal about half the body of the epididymis; beyond which I never could make it pass, being, I suppose, stopped there by the liquor of which the canals were full. By this preparation, one sees clearly the tubular texture of the *vas deferens*, and the wonderful convolutions of it where it has the name of *epididymis*.

30. When the spermatic cords pass the rings of the external oblique abdominal muscles, they are lodged in the common *tunica adiposa*, till they enter the scrotum, where no fat is to be seen, but the cords and testicles, involved in their vaginal coats, are immersed into a cellular substance, the cells of which all communicate with each other; so that water or air forced into either side, or at any part, readily diffuses itself through the whole of it: from whence it is evident, that there is no membranous or carnosus partition dividing one side of the scrotum from the other. In several subjects, air only passes from one side of the scrotum to the other at its upper part; and in some, one side of the scrotum is not inflated by blowing air into the other. What has been showed as a *septum scroti*, is the effect of a faulty preparation: either the cords and testes have been violently drawn out at an aperture in the upper part of the scrotum, and their places have been filled with some substance to keep the scrotum distended till it became dry; or the scrotum has been slit open on each side at its fore-part to take out the testicles; after which it has been stretched out on a board, and the penis has been supported to keep

keep the middle substance stretched till all was dry. By a preparation made in either of these ways, a firm septum may be formed; but then it is no more than the collapsed cells all glued together in the drying, and such as can be made in any part of the common *tunica cellularis* under the skin of lean people, where there is no fat. If we cut through the middle of the skin of the scrotum, and violently tear away one testicle from the other, we will be likewise led into a mistake concerning the structure of the parts here; the collapsed cellular membrane will have the appearance of a sac inclosing each testicle, and we shall believe the two bags were only applied to each other.—The way to have a right notion of the structure of the parts here, is to distend the cellular substance of the scrotum with air while the scrotum is entire and the testicles are in their natural place, and then to dry them; or rather to cut the skin all along the middle of the scrotum of a recent subject, and then to draw the skin gently to each side, cutting gradually what we have viewed sufficiently, and bringing the sides of the incision nearer together from time to time: then we will be sensible that the testicles are connected by cellular membranes, which are capable of being stretched to a very great extent, and when collapsed go into a very small space; and that the testicles are every where in such a substance.

31. What should prevent the vessels of these cells from separating an oily liquor into them, as is done generally into the *tunica cellularis* elsewhere, I do not know: but the want of fat here saves us the trouble we might have from the stretching of the skin and spermatic cord by its weight; and we are not so much exposed to bruises and other hurtful accidents, as if the scrotum was larger by the addition of fat.

I had occasion formerly (a) to observe, that the cellular substance under the skin, when it has no fat in it, puts on a muscular appearance, and wrinkles the skin: it does the same here in the scrotum; and these collapsed membranes entirely compose what is so formally described as a muscle under the name of *dartos*. Whoever will number the *dartos* among the muscles, ought to restore the exploded *tunica carnea* to its place among the general teguments of the body.

33. The cellular membranes at the upper part of the scrotum are firmer than

(a) In the first article of this Collection.

than lower down; and the difference becomes much more remarkable when they are stretched by any disease; this depends on their being connected to the top of the thigh on one side, and to the *os pubis* on the other, and some addition which seems to be made to them of fibres from the tendinous aponeurosis of the *fascia lata*, and from the suspensory ligament of the penis.

34. The skin and cuticula of the scrotum are of the same structure as elsewhere: but the little wrinkle called *raphe*, extended along the middle of the scrotum on the lower part of the penis and on the perinæum, has been thought to deserve particular notice; and by the cautions that are given to shun it in operations, one would imagine it to be something considerable. To me it appears no more than the skin stretched a little less in the interstice of the testicles than in other parts, and therefore making a larger wrinkle: for whenever the water or air, introduced into the cellular substance, distends the scrotum equally, the raphe disappears. An injury done to it, I am certain, is of no worse consequence than when done to any other part of the scrotum.

35. The principal artery of the scrotum on each side, is what comes from the crural artery; and, crossing over the anterior part of the spermatic cord, spreads its branches every where in the scrotum, and a large branch or two is given to the skin of the penis. Other smaller ones it has that come down from the epigastric and pudenda; and I have seen others rise up to it from the branch of the hypogastric, which serves the perinæum.

36. Its principal vein accompanies the larger artery, or frequently is a little higher up.

R E M A R K S

O N

INGUINAL HERNIÆ in MEN.

THE viscera of the abdomen cannot fall down through the rings of the muscles to form a true hernia in the groin or scrotum, unless the tense peritonæum covering those rings (§ 16. preceding art.) is either broken or stretched. The former seems to have been the prevailing opinion in Britain when the name of *rupture*, or *bursten-belly*, was given to this disease: the latter opinion, *to wit*, that the peritonæum is thrust down into a blind bag in which the bowels are contained, is what many operations and dissections have proved to be almost constantly the case.

The situation of the spermatic vessels (§ 4.) may let us see, that in herniæ the sac of the peritonæum, with the included viscera, must be always placed at the interior part of the spermatic vessels; and the description of the cremaster muscle (§ 14.) may teach us, that, in descending towards the scrotum, the sac may either enter within the cremaster, or may pass over it at the internal anterior part of the spermatic cord, the cellular membranes of the cord in the former case, and of the scrotum in the latter, yielding to the force pushing the viscera down.

In these cases the form and effects of the herniæ will be a little different.

When the sac descends within the cremaster muscle, the tumour will be more perpendicular, more oblong and tense, because of the bowels being restrained and confined by the muscle. The septum (§ 21.) will hinder it from descending to the testicle, which (§ 24.) will be felt at the external anterior side of the hernial tumour; and, if the sac with the bowels is pushed so violently upon the septum, as to stretch it, a rising ring will
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be formed round the sides of the testicle, and the epididymis is concealed.

If the hernial sac falls without the cremaster, it will descend towards the interior side of the spermatic cord; its form will be rounder, and the sac will not be so tense as in the former case; it may go down as far as the testicle, which, with the epididymis, will be felt on its external part. If the hernia is very large, the sac may be so distended, as almost to surround the testicle.

The effects of a hernia on the different parts forming the tumour will be these.

The stretched skin will have all its vessels, particularly the veins, considerably enlarged, which is a common effect of stretching the skin any where, but must be more remarkable here, because of the situation of the principal vein (§ 36.), the trunk of which is much exposed to be pressed upon. This distension of the vessels must be proportional to the pressure on the vein, the largeness of the tumour, and the time it has continued. A small, floating, recent hernia, will not have its cutaneous vessels so much distended as a very large strangulated old rupture of long continuance.

The cellular membranes, having their cells applied nearer to each other by the stretching, become firmer; and, by continuing in this condition, increase their thickness and firmness in the same way as we observed them to do every day in forming the sac of encysted tumours, and in many other cases. Those of them which are annexed to firm parts will suffer most in this way from the pressure; so that we need not be surprised at seeing sometimes a cross band, at the superior part of the scrotum (§ 33.), in hazard of strangulating the hernia, or to observe several membranous lamellæ that appear to be aponeuroses from the abdominal muscles (§ 19.)

What was said of the vessels of the skin, may be applied also to the cellular membrane, whose enlarged vessels will pour out liquors into the cells that are not violently stretched. Hence the scrotum becomes frequently thick in herniæ; and as the liquor is more or less viscid, the thickened scrotum will be more or less hard, so that we may observe it in all the degrees between a watery swelling and a firm scirrhus.

The peritonæum will not only have the sac containing the viscera af-

fectcd in the way the parts hitherto described are, but where it is stretched within the belly, near to the protruded part, it may be drawn into unequal wrinkles, which will likewise thicken, and may grow together.

The vessels of this depending sac will pour out their liquors in greater quantity; and, if the abdominal liquor is collected in drops, they will drill down into the bag; on which account we meet so frequently with a liquor contained in the hernial sac. When this liquor is mild, it is so far from being hurtful, that it is the best preservative against the concretion of the sac and its contained viscera, or of the viscera to each other. If this liquor becomes acrid, it will stimulate, give pain, and erode the solid parts.

The viscera contained in the hernial sac, must draw those they are connected to within the belly, which may make these parts also to suffer. Those in the hernia being straitened in the preternatural sac, especially where the membranes are supported by firm parts, which prevent their stretching, as at the ring of the external oblique muscle, the contracted wrinkled peritonæum, or the cross membrane at the top of the scrotum (§ 33.), their vessels will be pressed; and the returning liquors being most easily stopped in their course, all the vessels below this straitened part will be stretched, and the volume of the parts to which they belong will consequently be increased.

All the hollow viscera having some fluid or other substance contained in them, and such viscera being often engaged in herniæ, their contents may be retained and collected in this depending part, by which the viscera are distended, the vessels are more stretched, and the bulk of them is increased. The heat of the body, and the corruption which these contents of the hollow viscera are exposed to by stagnating, may make a rarefaction of these contained substances, and consequently a greater distension of the parts containing them.

The distension, obstruction, and irritation, may occasion pain; and that effort nature makes for being freed of the cause of such disorders which we call a Fever, is raised, from which there is danger of all the disorders being increased; the vessels may be more distended, which will increase the irritation and pain; the heat and corruption will consequently increase, and make the distension of the parts greater; the obstruction

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may become complete, and therefore the parts may mortify. What is now described, surgeons call the inflamed strangulated state of a hernia, the progress and symptoms of which are told accurately enough by most writers on this subject, and therefore I shall not give any detail of them.

If the effort of nature should prevail, and the obstruction be removed by the fever, it must be either in the way of *suppuration* or *resolution*; terms so well known, that it is needless to explain them.

In the more favourable of these two cases, the *resolution*, the viscera and their contained bag, being, while in the inflamed condition, pressed close together, and no liquors being poured out, are liable to grow together; and they always acquire an addition of substance which they do not quit easily; so that they are thicker and firmer afterwards. In the suppuration, besides the danger of concretion during the inflammation, the pus not having any passage out, may become acrid, erodes the part it touches, and may be taken into the vessels so as to create various disorders.

When there is no impediment, nature or art can make the bowels return into the belly by the same passage which they came out at; and if that passage can be sufficiently blocked up, a return of the disease may be prevented.

When the bulk of the parts becomes so great that they cannot return by the passage they came out at, or there is a concretion of them to the neighbouring parts, they must remain in this morbid hernial state till their bulk diminishes, or the passage is enlarged, or their concretions are dissolved.

The bag in which the viscera are contained in a hernia, having little springy force or contractile power to make it shrivel itself up into the belly, and being so thin that artful pressure cannot be so well applied to it, and being immediately contiguous to stretched membranes which may grow to it; for these reasons the bowels often return into the belly when the sac is left behind; and, being pressed at its upper part by the substance blocking up the passage through the muscles, is made narrow there; or its sides may grow together, while the lower part of it may be filled with water from the abdomen, or from its own vessels (*a*); or, if this does not happen, it shrivels and diminishes. See § 18.

(a) Saviard, observ. 22. Le Dran, observ. 75.

When the viscera are straitened any where in their passage down to the hernia, the spermatic vessels, which are placed behind the sac containing the viscera, must suffer more or less; and thence a varicous *corpus pampiniforme*, thickened spermatic cord from the repletion of its cells with liquors, water collected within the *tunica vaginalis* of the testicles, swelling of the testicle itself, inflammation of all these parts, and all the consequences of inflammation, concretion, suppuration, gangrene.

It is evident how variously these different effects of herniæ may be combined, and of what different degrees each of them may be; and their description may serve to make us know them when they happen to any patient.

Though the bowels forming a hernia are generally included in a sac formed by the protruded peritonæum, yet it is not impossible that the peritonæum may be torn by a violent sudden effort causing a hernia (*a*); or though the peritonæum descended at first, it may be bursted by some external violence (*b*), it may be eroded by pus, or fall away by gangrene (*c*).

Allowance being made for the want of the sac, the effects of this rare kind of hernia may be easily understood by what was said of the other; and the want of a tense bag covering the bowels, with the history of the cause of the disease and its progress, will make surgeons judge when this is the case.

What I have hitherto mentioned may happen, whatever is the bowel that forms the hernia; but there are some specialities which attend the several viscera engaged in this sort of tumour, that had need to be attended to.

The intestines and omentum are the parts which fall most frequently down, the appearances and consequences of which are well enough described in several of the most common books.

Instead of an entire piece of intestine being thrust out, which commonly is the case, one side of a gut has been stretched out into an appendix cæca, which was protruded out at the rings of the abdominal muscles (*d*). When this happens, the ingesta will not be stopt in their passage towards

(*a*) Garengot des Operat. chap. 5.

(*b*) Id. ibid. Mery, Memoires de l'Acad. de Sciences, 1701. (*c*) Saviard, observ. 56.

(*d*) Littre, Memoires de l'Acad. des Sciences, 1700. Mery, ibid, 1701.

towards the anus, and the patient will go to stool, even though a strangulation of the hernia should come on: whereas, when the whole diameter of the gut is straitened by a strangulation, the ingesta will be stopt at the hernia; after the guts below it are emptied, the patient passes no more fæces, and the ingesta regurgitate towards the stomach and are vomited.

The bladder has sometimes been found to fall down in a hernia (*a*): the fluctuation of a liquor which can be pressed into the body, to occasion a desire to make water, or to run immediately out by the common urinary passage, are the symptoms by which this species of hernia may be discovered.—The manner in which the peritonæum covers the fundus and back part of the bladder, and the way it is connected to the containing parts of the abdomen at its lower part, would make one reasonably believe that the bladder will not carry a sac of the peritonæum down before it; but that one side of it gradually thrust between the peritonæum and muscles, would be stretched out at the rings of the muscles to the scrotum, where it would lie either behind or at the internal side of the spermatic cord; and, if it remained there any time, would grow to the contiguous parts.

Though I treat only of the tumours of the scrotum, it may not be altogether impertinent to mention here, that the other sex have had the uterus thrust through the rings of the muscle to form a hernia (*b*), which there would be a difficulty to discover if there was no child in it, whose stirrings would lead us to the knowledge of the contents of the hernia.

If the progress and symptoms of any tumour in the groin and scrotum are accurately enough examined, one who is acquainted with the seat and nature of the different diseases which happen here, will seldom be in danger of mistaking any other disease for a hernia, or of judging a hernia to be some other disease.—One of the cases which would be most liable to occasion a mistake, is a testicle lodged either naturally at the ring of the abdominal muscle (*c*), without having been observed till some accident makes it swell and be pained, or a testicle retracted thither by inflammation.

(*a*) Ruyfch. observ. 98. Mery, Mem de l'Acad, 1713.

(*b*) Michael Doring de Hernia Uterina Epistola.

(*c*) Parè, liv. 8. chap. 18. Jac. Oeth. lib. obs. propr. Act. Hafn. Vol. I. obs. 156.

inflammation or contusion (*a.*)—No testicle being found when sought for in the scrotum, the figure and greater hardness of the knot in the groin, and the absence of the most common symptoms of a hernia, suffice for making us distinguish this case.

The prognoses of herniæ depend on so many circumstances of the patients and of the symptoms, that I choose rather to pass them altogether, than to enter upon the numerous suppositions which might be made.

That herniæ should be reduced as soon as possible, all agree. To effectuate this, without cutting or eroding, is what surgeons call the *taxis*. For this purpose, such a posture of the patient's body as makes the viscera press least on the rings of the abdominal muscles, and relaxes the skin and muscles most, is of great advantage; such is lying on the back, with the hips and shoulders raised higher than the loins, and the thighs bended forwards without using any effort of the muscles. While the patient lies thus, the surgeon gently pushes the viscera up with his fingers alternately applied to a small part of them at once, as is commonly described well enough, and therefore I shall not here transcribe the directions for doing this operation; but must observe, that sometimes, after the bowels seem to be pushed up into the abdomen, a soft knotty substance remains unreduced, and resists all the efforts to reduction, till the patient's vessels are emptied by venæsection, repeated purgatives, and low diet. The varicous feel which this substance had, in the cases I saw, made me judge it to be the mesentery with its vessels distended.

If this attempt does not succeed, general directions are given for removing the impediment to reduction by plentiful bleeding, emollient clysters, fomentations, and poultices. As all these are calculated for the inflamed state of herniæ, they do very ill, in my opinion, who prescribe no other method: for though herniæ, especially recent ones, that will not reduce, are liable to inflame and strangulate, which very soon brings the patient into danger of his life, and therefore surgeons ought to be much on the watch to guard against inflammation; yet an over care to prevent it ought not to make them do things that may retard the reduction, or make it more difficult, since it is the most effectual preservative against all the bad symptoms. The directions mentioned above, and al-
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(*a.*) Boneti Sepulch. Anat. l.b. 3. § 30. obs. 3.

most universally ordered and put in practice, are, I think, in this respect faulty. If, for example, the obstacle to reduction is the rarified air within the guts distending them, would not the warm relaxing fomentations and cataplasms increase the distension? Since the first publication of this paper, I have seen a case of a hernia related by Dr Huxham (*a*), who blames the repeated application of hot fomentations for the vast expansion of the bowels. I have seen cold claret or snow make the distended intestines return into the belly after the antiphlogistics, as they are called, had increased the swelling, and the common efforts of reduction had failed.—In the same way, when the tone and contraction of the guts is too weak for pushing the ingesta, which descend into the part of the gut engaged in the hernia, upwards, to go forwards towards the anus, and thereby these ingesta come to be collected in the hernia, and to make the intestine there too bulky for passing the ring of the abdominal muscles, bleeding and relaxing medicines will weaken the tone of the guts more, and so increase the disease: a brisk stimulus given by the mouth or anus, would much more effectually make a cure. I have many times made a rupture reduce, by giving powder of the jalap root and sweet mercury, when neither hands nor emollients did any good.—Will not the soft flabby omentum, if it is lodged in the hernia, be always more relaxed, and swell more by the application of emollients? What I would recommend, then, is to examine accurately the circumstances of the disease; and to vary the method of cure according to the nature of the obstacle to reduction, whether it is air, feces, increased growth of parts, or overstretched inflamed vessels: which last only admits the use of the things that are prescribed as proper in all cases; and, even in it, caution is necessary in using those medicines.—If a person is old and weak, the loss of too much blood may sink him, and make the liquors stagnate in the distended vessels, to bring speedily a mortification.—If the patient is of a very lax constitution, bleeding to excess, and the application of emollients, may weaken the vessels so as to make them continue in their distended state.

If the viscera will not reduce by the methods hitherto proposed, and the symptoms of strangulation come on, there is a necessity of performing

(*a*) Philos. Transact. Numb. 459. § 22.

ing the operation for the bubonocèle or completè hernia; the rules for which, laid down by late writers, are well enough accommodated to the most ordinary circumstances of herniæ; though it is plain, that, as these are various, operators must sometimes change their manner of working. I shall not therefore give you the trouble of reading a description of the operation for the hernia in the groin or scrotum; but shall make some remarks on parts of the operation where there is doubt what ought to be done, and on some of the more uncommon cases.

When the viscera are not confined within a sac, which I observed was sometimes the case, more than ordinary care is to be taken in making the incision through the teguments, lest the bowels should be wounded.

When the sac is laid bare, it ought to be considered, whether it is to be left entire, and pushed up into the rings after the bowels are reduced, or if it should then be laid open. Circumstances must determine this. If the disease is recent, with the sac thin, and not folded into wrinkles, or straitened where it is coming through the passages in the muscles, or grown to any other part; if the bowels are sound, and in no danger of gangrene, or are not grown to the sac; if the liquor in the sac is limpid, and no fœtor or erosion is to be observed; if all these circumstances appear, the reduction of the sac entire will be of service to block up the passage, and to prevent the viscera from being exposed to the action of the external air.—Where these circumstances do not meet, the sac ought to be opened, for very obvious reasons: the wrinkled or contracted sac may continue the strangulation after the ring of the muscle has been cut (*a*); the sac or bowels fixed by concretion will not reduce; an opened gut will let out the ingesta; and a mortified omentum will slough off into the abdomen, from which there is no exit; and, stagnating there, they will corrupt more, and do great mischief. The same effect may be expected from the liquor in the sac, if already acrid.

If there is a considerable concretion of the bowels to the sac, and this is grown to the scrotum, the surgeon had better leave the bowels unreduced, after cutting the strangulating ring, than risk the life of his patient by a tedious dissection of the concreted parts, especially if the guts or bladder are the parts grown to the sac: for when the strangulation is removed,

(*a*) Le Dran, *obf.* 50.

moved, the viscera may possibly shrivel up; or if they continue down, a cicatrice may be brought over them; in which condition the patient may live a considerable time.

When, in such a concreted state of the bowels, the strangulation depends on some piece of a gut lately fallen down, this should be reduced, while the other parts of the bowels are left down (*a*).

Though the gut in a hernia be mortified, surgeons ought not to give over the care of their patient, since there are several instances of such people surviving with either an artificial anus at the ring (*b*), or nature has reunited the distant pieces (*c*), or she has been assisted by art to join them (*d*). Mr De la Peyronie's method of stitching the parts of the mesentery belonging to the two ends of the divided gut, seems preferable to Ramdohrius's practice of stitching the gut itself; for this irritates more, and the threads of the stitch will not come away so easily, and more readily leave an opening in the gut, than when the stitch is made in the mesentery.

Though nothing appears in sight when the sac is opened, except the omentum, the surgeon ought to examine carefully, whether any ply of the intestine is wrapped up within the caul, that they may be disengaged from each other, lest the gut be cut or tied, if there is occasion to perform any such operation on the omentum.

If the omentum is not absolutely mortified, it should have the chance of recovering by being reduced, since, at the worst, no more inconvenience will happen from the separation of what nature mortifies, than what the ligature, which must be made on the present supposition, occasions.

It is a doubt with me, whether the omentum ought to be tied before the mortified part of it is cut off: for by the ligature more of it is destroyed than would be if the gangrened part separated of itself; because the liga-

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(*a*) Morand, in De la Fay's notes sur Dionis, p. 55.

(*b*) Mery, Memoires de l'Acad. des Sciences, 1701. Cheselden's Anatomy, p. m. 69. Le Dran, obs. 60.

(*c*) Courtial, obs. 6. Medical Essays, vol. i. art. 20.

(*d*) De la Peyronie, Mercure de France, Juillet 1732. Ramdohrius Commerc. Norimberg. 1731, Spec. 26.

ture is made in the sound part, and by the thread the omentum is drawn into a knot, which may do hurt. Supposing the mortified part to be cut off as near to the sound part as the thread in a ligature is put from the place where the caul is to be cut off, would the cut vessels in the remaining mortified part bleed? or would the gangrene more readily spread without a ligature than with it? The answer to these two questions (which I neither have experience, nor can I find any observations of others to assist me to answer) would determine what the practice should be. Since what is above was first published, I have read two cases (*a*), where there was no hæmorrhagy, nor further progress of a gangrene, after cutting away a considerable share of the omentum on which no ligature had been put.

After the hernial sac is emptied by the reduction of the bowels, a membranous substance will sometimes appear, resembling a piece of gut (*b*), which is no more than a folding or doubling of the sac, and ought to be let alone, without fatiguing the patient with the dissection of it.

After the bowels are reduced in appearance, the surgeon ought to search with his finger, lest there be any contracted ringlet, cross bars, or productions of the peritonæum above the ring in the muscle, which might continue the strangulation of the gut, that they may be cut to make the gut quite free (*c*). Such strangulating rings are most readily to be met with in people who have long wore trusses, which have pressed the sides of the neck of the sack together.

When the intestine is opened, or there is gangrene or inflammation on it, that may give reason to expect it will be opened when the suppuration comes on after the reduction of a hernia, or if it is expected that any part of the omentum will separate, the peritonæum and ring of the muscle ought to be kept open, to allow the putrid matter to be evacuated; but the substance introduced into the passage ought neither to be so hard as to bruise or irritate, nor so large as to hinder liquors to drill along it, lest an inflammation be raised, and the pus, fæces, or aliment, be pent up within the abdomen, to the ruin of the patient.—But when there is no reason to expect the effusion of any such putrid substances into the abdomen,

(*a*) *Philos. Transact.* Numb. 443. sect. 8. and Numb. 450. sect. 2.

(*b*) Mery, *Memoires de l'Acad. des Sciences*, 1701.

(*c*) Le Dran, *obs.* 58.

men, the sooner we can shut it up the better. If we could raise up the hernial sac from the spermatic cord with little trouble, and then put a ligature round it close by the ring of the muscle, it would shut up the passage most effectually during the cure, and might be a means of security against a relapse.

It may be said in general, that the *antiphlogistic regimen* is to be observed after this operation: but regard must be had to the constitution of the patient, and circumstances of the disease, in prescribing it; for these will sometimes oblige practitioners to alter the common method.

When the gut has been opened or divided, the patient needs to guard against too full meals for a considerable time after, or for all his life, if the gut has been divided quite cross, to prevent the bad effects which the pressure of a large quantity of food, stopping at this part of the gut, which is generally straitened, might produce.

After the viscera of a hernia have been reduced, the passage in the abdominal muscles, by which they escaped, must be straitened or blocked up, to prevent a relapse. While this is doing, the viscera must be hindered to come out, by the patient lying horizontally on his back, with his hips a little raised, and by a proper bandage.

The dilated parts have sometimes been so strengthened by the application of astringent medicines, as to keep the bowels up (*a*); generally, however, they are insufficient for the purpose.

By pressure continued long, the sides of the peritonæum have been made to grow together (*b*); but unless the ring of the muscle make a sufficient resistance, the peritonæum thus folded will not do it.

If the passage be kept a long time from being dilated, the sides of it gradually contract themselves, and become firmer, so as to hinder the falling down of the bowels; for this purpose different bandages have been contrived.

The spica bandage, with proper compresses, answers the purpose very well; and is always used where there is wound or ulcer, because it can be easily cleaned: but to people who are to wear the bandage long, and in the mean time are to be out of bed, and to move, without any fore to dirty the bandage, the spica is inconvenient, by the trouble there is in applying

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(*a*) Medical Essays, vol. i. art. 28.

(*b*) Le Dran, obs. 65.

and undoing it, and by the turns of it frequently sliding out of their place; wherefore to such, a compound bandage is generally applied.

The bolsters of most compound bandages or trusses are much too soft; they can yield as much as to allow the viscera to come out, when the patient makes any strong effort that pushes the bowels upon the bolster; they should be very hard stuffed, or made of cork, or some such substance, with leather stretched over it.—The shape of these bolsters is generally, too, very faulty: the convexity to be applied to the skin is either equal from the superior broad part to the inferior narrow point, or very gradually diminishes all the way; by which the point being applied upon the *os pubis*, the part of the bolster above it is borne off from the skin, and a hollow is left just at the rising of the muscle, to allow the bowels to come out; especially when, by bending the body, the upper end of the bolster is also forced outwards. They ought to be made with such a sudden failure of the convexity, that they may fit close to the hollow immediately above the *os pubis*. See such a bolster presented Plate VI. fig. 1.; or they ought to be made thicker below than above, applying the thickest part immediately above the *os pubis*.

The compound bandages which are made for children, without any steel or other firm substance on the outer surface of the bolster, can have very little pressure on the rings, as they are commonly applied with the circular belt sewed to each side of the bolster; for their convexity soon becomes all external by their application; whereas, if the circular belt were brought cross over their external surface, the full effect of the pressure might be had on the rings of the muscle. To bring the circular belt thus cross the bolster, the belt must be put lower down than it is commonly applied.

If a right-made bandage, that prevents the falling out of the bowels, is kept applied several years to children, the peritonæum and ring may become so firm, and the viscera may grow so large, that the rupture may not afterwards return: but if the bandage of children allows the viscera to come out sometimes, and, in adults, where the stretched peritonæum and dilated ring cannot so well recover their former state, and the bowels do not grow larger, there is always danger of a relapse, if a constant pressure be not kept on the ring, at least when the person is in an erect posture;

future; nay, I have observed, that most of those who wore a bandage for this disease when children, suffered a relapse if they laid aside the bandage when they grew up.

Formerly several different operations were practised for blocking up the passage by which the bowels fall out, after they were reduced. The castration, *punctum aurcum*, and cauterizing, were laid aside after trusses came to be tolerably made, till some years ago the cautery was revived here in Britain with great eclat, notwithstanding its being practised by those who were altogether ignorant of the nature of the disease, and of any reasonable intentions of cure. By their promising more for its success than could be performed by it, to wit, a complete and absolute security against any return of the disease, whereas it failed in most or all adults it was practised on (a); and by the many blunders those ignorants committed, the reputation of this operation sunk in a little time so much, that it is now neglected, though it would seem capable of being performed safely and with some advantage.

What could be reasonably proposed by this method is, after reducing the hernia, to destroy the skin and fat covering the ring of the external oblique abdominal muscle, and to make new flesh rise round the spermatic cord in the ring itself: by this new flesh the ring may be blocked up; and bringing a firm cicatrice immediately over the ring, instead of the flexible *tunica adiposa* and skin, a sort of bolster might be formed for resisting the viscera when they were pushed outwards.

The late operators applied for this purpose a caustic to the skin, without having, so far as I could ever learn, any rule to know when it had eroded deep enough. If their eschar was too superficial, the design of the operation could not be answered; if the caustic eroded too deep, the spermatic vessels would be destroyed. I have been assured, that after this operation was performed, the testicles of some children, who had undergone it, shriveled daily away, so that they were effectually castrated. When the caustic penetrated so far as the fibres of the cremaster muscle, would not the testicle be drawn convulsively up towards the ring of the oblique muscle? and would not a contrary caustic immediately stop the further action of the one first applied? Though it is reasonable to answer:

(a) See Houston's History of Ruptures.

swer both these queries in the affirmative ; yet never having made the trial of the caustic in this way, I shall desire none to practise it, since they can do what I mentioned to be intended, without any risk, by pinching up the teguments which lie over the ring, and then making a longitudinal incision some inches in length ; the middle of which ought to be over the ring, the depth of it such as to bring the spermatic cord in view ; then by the lunar caustic, small quantities of the common caustic, or other escharotics rightly applied, destroy the fatty cellular membranes in the ring and under the skin ; after which, hasten a cicatrice, by the application of ardent spirits, or tinctures made with them ; and by this endeavour to make the cicatrice adhere to the tendon in the way cicatrices generally do to bones, part of which has cast off where there has been any ulcer of long standing near them. By lying a-bed to prevent the viscera coming out, during the time of the cure, which allows the ring of the muscle to contract, and by the cicatrice, I have seen patients walk afterwards without the bowels falling out, though they wore no bandage : but this cure is not to be depended on. For though the new flesh, which sprouts out from cellular substance suppurating, appears at first firm, yet it afterwards becomes as mere cellular membranes as any where else ; as every surgeon must have seen who has had occasion to examine a wound or incision made where a wound or ulcer formerly was : and though the cicatrice adheres firmly at first to the tendon, yet it gradually becomes more loose, and is itself more capable of stretching ; and therefore yields to the viscera pushing it with violence, as it did in one of the boys whom I saw very carefully treated in this way : so that I would advise nobody to throw away the bandage after they had undergone the cauterizing, otherwise they run an evident risk of the hernia returning. This method does no more than make the persons who undergo it less exposed to the falling out of the viscera, if their bandage should at any time shuffle, or be borne up off the rings.

The last method I shall mention for blocking up the rings, is by the operation of the bubonocoele ; concerning which I made some remarks already. This has generally been thought to prove an absolute cure ; but, for the reasons given against the cautery proving such a cure, I join
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with Dr de la Faye (*a*) in opinion, that it is the safest course to wear a bandage likewise after this grand operation. And Mr Amyand tells us (*b*), that he has seen three or four instances of herniæ returning after this operation; and therefore concludes, that it is only a palliative cure.

(*a*) Notes sur Dionis, p. 61.

(*b*) Philos. Transact. Numb. 443. sect. 8.

N^o 34.

OF THE

T U M O U R S

I N T H E

SCROTUM, commonly called FALSE HERNIÆ.

SURGEONS generally give the name of false herniæ to the tumours in the scrotum occasioned by any other cause than the falling down of the viscera into it; and as these false herniæ begin below and rise upwards, whereas the true herniæ must begin above and descend afterwards, a pretty sure sign is thence taken by which the true herniæ may be distinguished from the false.

Because these false herniæ are of different natures, and contain different substances, they are distinguished into several classes, of some of which again there are different species, according to the particular seat or nature of the tumour.

I have wrote the following remarks on each of these false herniæ, without pretending to give a full and complete account of them, but with the view to put surgeons on observing more exactly the diseases they treat.

Of the H Y D R O C E L E.

WHEN water forms a tumour any where within the scrotum, the disease is called *hydrocele*; of which there may be reckoned several different kinds, according to the different parts the water is lodged in.

1. When water diffuses itself in the cellular substance of the scrotum, the disease has the same appearances as anasarous or leucophlegmatic swellings

swellings in other parts of the body; allowance only being made for the looser cellular substance, without any fat in the scrotum, than elsewhere.

The causes of this scrotal anasarca are very different; one of the most common is a more general anasarca spreading from the thighs to the scrotum. Any tumour pressing the vein of the scrotum produces a hydrocele of this kind, in the same way as dropsies are caused in other parts by a ligature or pressure applied to their veins. Thus a tight garter makes the foot and leg to swell; thus the legs of women with child are often very œdematous; thus the monstrous swellings are caused, which sometimes happen to the arm when a scirrhus in the arm-pit becomes large, &c. For this reason it is, that often in the true herniæ, and frequently in the false ones, when the tumour rises high, the scrotum becomes very thick. One cause more which I shall mention, is the stoppage of the urine by a stone, excrescence, or stricture in the urethra, when the urine bursts through this canal, and diffuses itself into all the cellular substances of the scrotum, penis, and neighbouring parts.

The symptoms of this kind of hydrocele are common to any other œdematous or watery swelling, and are well enough known by all surgeons.

In the cure, particular regard is to be had to the cause; for unless that is removed, no cure can be expected. The more general anasarca is to be cured; the hernial tumour is to be removed; the stone, excrescence, or stricture, is to be taken away. And then, in the œdema of the scrotum, depending on the two former causes, the common methods are to be put in practice. But when urine is diffused in the cellular substance, we need make no attempt to cure it by corroborants, hydragogues, &c.: for the urine soon corrupts; either is not absorbed or reabsorbed into the blood from the cells; or, if it could be taken up, it would produce a general disorder in the body, and would leave enough of its grosser acrid parts to raise inflammation and all its consequences, abscesses, gangrenes, &c. The most speedy and safe method of cure in the case of a hydrocele from diffused urine, is soon to make numerous deep scarifications, and to bring the wounds to suppuration as fast as we can; otherwise we may lay our account that at least several abscesses will be

formed, after which there will be numerous callous sinuous ulcers to cure, of which I have seen several examples.

2. A watery liquor may be poured into the cellular substance of the spermatic cord, as well as into the cells of the scrotum, and is occasioned by like causes. If the cellular substance behind the peritonæum becomes œdematous, the watery liquor will drill down into the spermatic cord; if the spermatic or scrotal veins, but especially the spermatic, are compressed, or if any other way the return of the blood from the testicle be impeded, this species of hydrocele is formed. It is therefore often to be observed in those who have an universal œdema, in people whose abdomen is violently stretched by a hydrops ascites, distended liver, or any other tumour in the belly, and in such as have the true or false herniæ.

The symptoms of this disease are an oblong soft tumour in the spermatic cord; which, by continuing pressure on it some time, may be diminished or made to disappear, the water being gradually squeezed up into the cells behind the peritonæum; by changing the patient's posture, its figure changes; lying horizontally with the scrotum supported, it becomes more oblong, and of near equal dimensions from the rings to the upper part of the testicle; by standing erect with the scrotum pendulous, it becomes larger in the lower part, and smaller at the upper.

Generally, when the cause of this swelling is removed, the tumour disappears; if it does continue, the same indications of cure are to be pursued as in the former species, depending on the two first causes I there mentioned, which are similar to the causes of this.

3. Most encysted tumours are no more than a cellule of the *membrana adiposa* distended by a liquor stagnating in it; and therefore we may expect, that sometimes a cell or two of the spermatic cord may be formed into hydatides, which have been taken notice of by Albucasis (a), and one or two late writers in surgery, as a species of the hydrocele.

The figure of this tumour is oblong, the cyst being confined by the cremaster muscle; the firm cyst and fluctuating liquor are felt, and the testicle is situated below it.

The general methods of cure are nearly the same as are directed in the collection of water between the *tunica vaginalis* and *albuginea* of the testicle, which.

(a) Chirurg. pars ii. p. 62.

which is the kind of hydrocele most commonly described. Though tapping is the palliative, and opening the sac is the radical cure here; yet it is to be observed, and indeed is plain from the seat of the tumour in this species of hydrocele, that neither trocar, caustic, nor knife, are to be applied at the bottom of the scrotum, as is done in the common hydrocele; because, if the operation was done at this place, the body of the testicle must be pierced through before any water could be evacuated. The external side of the scrotum is the most convenient part for making the opening in this case; flunning, if we can, the distended veins of the scrotum. When there are two separate distinct watery cysts here, as it is said there have been (*a*), one remains distended when the other is evacuated by an operation, and the operation must be repeated or continued to open the second.

The following history of a case of this species of hydrocele, where both disease and practice were not in the common way, may not be impertinently joined to an account of a disease concerning which you will find very few observations.

One who had formerly been completely cured of the common hydrocele, or water between the coats of the testicle, by opening the whole sac, having in the evening made merry at a bottle, was seized in the night-time with pain and swelling in the scrotum; which being attended with a quickness of the pulse, was believed to be of the inflammatory kind, and for several days he was treated with a view to the inflammation: he was several times bled, antiphlogistic purgatives were given, he was kept on a low cooling diet, and emollient fomentations and cataplasms were applied. The scrotum swelled greatly, the skin of it became red, and a tumour within it rose as high up on the left side as the ring of the external oblique abdominal muscle. At last a fluctuation was felt in the parts where the teguments were thinnest and most flexible. A trocar, the canula of which was open in one side, was thrust into one of these parts; and, upon withdrawing the stilet, clear water rushed out. The surgeon had introduced the trocar so perpendicularly, and the teguments were so rigid, that, notwithstanding the advantage of a scoop-handle which the canula had, he could not turn it so oblique as to make use of

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(*a*) Garengot, *Operat. de Chirurg. obf.* 28.

it as a director to run a bistoury upon for opening the sac as he intended. In this attempt most of the water was evacuated ; the patient was therefore allowed to recruit his strength some time, in which the sac filled again. Then a large train of common caustic was laid upon near the whole length of the scrotum towards the outside : and immediately after the caustic had had a sufficient operation, an incision was made through the teguments two inches thick into the sac about the middle of the tumour ; and, a finger being introduced into the opening, one of the blades of a pair of scissors was carried upon it, by which the sac was opened first upwards to the ring of the muscle, then downwards to the septum immediately above the testicle. What the quantity of water evacuated was, could not be exactly known, most of it being spilt on the floor by accident, but it was considerable. The wound bled pretty briskly at first ; but the hæmorrhagy stopped soon after the cavity and wound were filled with *charpie brute*, unformed lint ; the scrotum was covered with compresses, and supported by a suspensory bandage.

There being no bad appearance of any kind, the dressings were not removed for three days, when the beginning suppuration and oozing water had made them wet. At the second dressing the sac feeling of a callous hardness, and there being a considerable thickness between it and the spermatic vessels, the doffils to be put contiguous to it were wet with spittle, and then rolled in fine powder of red precipitate mercury ; the eschar made on the teguments by the caustic having suppurating ointments applied to it.

When the eschar came off, the fore of the scrotum had a scirrhus appearance both in its hardness and unequal surface : however, seeing the caustic in this first application had no bad effect, it was resolved to waste the scrotum with it ; for which purpose pledgits wet in spittle were pressed on the powder of common caustic, and applied to it.

The precipitate was continued to be applied daily to the sac till it became soft, granulating flesh rising every where, and laudable good pus coming from it. The caustic was renewed to the scrotum as often as the eschar of the former application fell off, till it became near of a natural size and firmness.

The sac was then allowed to heal, which it did very soon. Except a small equal scar, nothing is now to be observed on the scrotum ; and the patient

patient has been several years, since the cure, without the least symptom of hydrocele.

4. The collection of water between the vaginal and proper coats of the testicle, is so well described, and the directions for treating it are so full, in the common books of surgery, that I need not enter into any particular detail of it. It may not, however, be amiss to observe, that when tapping is to be performed for relief of this disease, the skin of the scrotum ought to be stretched very tense where it is to be pierced: and the tumour is to be made very oblong by the surgeon, that the instrument may penetrate easily, which it will not do when the skin is lax; and that there may be sufficient space between the lower part of the sac, where the perforation is to be made, and the testicle, to prevent any injury being done to the testicle by the point of the instrument.—When the quantity of water in this hydrocele is small, I think the lancet a safer instrument for making a perforation into the sac with than the trocar, which always requires a push that makes the teguments and sac yield so far that the point of the fillet comes too near the testicle before the canula is forced through.

Considering how readily contiguous inflamed parts grow together, and how many instances there are of people having a radical cure made of this hydrocele by inflammations coming on the parts, it would seem no unreasonable practice to endeavour a concretion of the two coats of the testicle when they are brought contiguous, after letting out the water through the canula of a trocar, by artfully raising a sufficient degree of inflammation. This, to be sure, must be done cautiously, and so that the surgeon can reasonably expect to be master of the inflammation; and therefore the application of all irritating medicines, the operation of which he could not immediately stop, or any single mechanical effort, the effect of which he could not be sure of, are not to be employed. Suppose the canula of the trocar was to be left in, by the extremity of it rubbing on the testicle, an inflammation might be gradually raised, the cause of which could be taken away as soon as the surgeon thought fit. I have never seen this practice attempted, and therefore I mention it diffidently.

The following case of a sac in the spermatic cord, cured in this way,
may,

may, however, encourage us to expect success also where the water is contained within the vaginal coat of the testicle.

A man who had the *paracentesis* several times performed for the evacuation of water lodged between the vaginal and proper coat of the right testicle, received a violent bruise on the distended scrotum by his horse stumbling. The pain and inflammation occasioned by this bruise confined him to bed some time, till they were removed by evacuations, fomentuses, &c. as in common inflammatory cases. The hydrocele was no more observed after these symptoms went off.

Some years after, a hydrocele of the third kind here mentioned, viz. a collection of water found in a sac of the spermatic cord of the same side where the former hydrocele had been, was plainly felt. An incision about an inch long was made into the side of the scrotum, by which near a pound of water was let out. A pipe, four inches long, of the shape and diameter of a female hollow catheter, with a smooth shut extremity, and openings in the sides, as that catheter commonly has, but with a plate fixed at the other end, to serve as shoulders which should hinder it from sliding all into the cavity where the water had been lodged, was introduced and allowed to remain two days.—By this irritation, so violent an inflammation was brought on, as would not resolve, but suppurated, and from it a very great discharge of pus was made. After the inflammatory symptoms were well off, the silver pipe was employed as a tent introduced into the cavity, being taken out every day to be cleaned, and again introduced, till the cavity filling up from the bottom, would no more admit it; and soon after the sore was completely cured, without the least return of any kind of hydrocele afterwards.

In this, and the case formerly related of this kind of hydrocele, and in two other such cases, I put my finger into the sac, and felt what is called the *septum*, between the spermatic cord and testicle, § 21. with the epididymis, but could not touch the body of the testicle.

In opening the whole sac for making a radical cure of the hydrocele, where the water is collected between the vaginal and proper coat of the testicle, I would prefer the application of a caustic along the tumour to destroy the skin, previous to an incision into the sac: for by the caustic, one has a larger opening of the teguments than by any incision; and a
large

large enough external orifice is always to be preferred in a hollow ulcer, which this must become, to a confined orifice, which puts the patient and surgeon both to the uneasiness of keeping it always open enough, and runs the risk of making a sinuous ulcer after all. This is more especially necessary, where a membranous bag is opened and afterwards to be filled with new flesh; for such membranes are longer in coming to suppuration, and in sending out granulated flesh, than other parts are. The time which the eschar takes in casting off, especially when the surgeon applies spirituous medicines to prevent its separation; this time, I say, wherein the orifice of the fore cannot contract, compensates for the slower suppuration of the sac; and the inflammation that continues in the obstructed neighbouring vessels to the eschar is frequently, in lax habits or parts, of use to promote a right suppuration when it is needed.

When the sac is opened in the operation now described, the testicle generally starts out at the wound, where it is in danger of being injured; the surgeon ought therefore to take care to keep it within the scrotum. I once saw the testicle left out of the scrotum after the operation for the hydrocele, till the granulated flesh, rising from the coats of the testicle, formed a covering for it, without the patient having a bad symptom all the time of the cure.

I hope nobody will believe that such rough treatment as I mentioned the sac of the spermatic cord, to have undergone in the patient whose history I have related lately, is ever to be given to the testicle when its *tunica vaginalis* is opened: The testicle will not bear such irritation, as may appear from the following history. The watery discharge continuing, and no granulated flesh rising, two weeks after the operation for this species of hydrocele had been performed, the patient put waxed thread twisted into the sac; then slept some hours, and awaked with sharp pain in the testicle, which soon brought such a smart fever as required four plentiful bleedings before it went off; but being succeeded by a mild suppuration, and granulated flesh rising from the sides of the cavity, a complete cure was soon made.

Though the inflammation and fever are for ordinary strong, when the testicle is irritated; yet the patient generally must undergo them, before a complete cure can be made of this most common kind of hydrocele:
for

for the oozing of water into the sac continues till the inflammation causes some suppuration on the surface of the coats of the testicle.

I cannot conclude my remarks on this hydrocele, without mentioning a case which I don't remember to have seen described. A young man, who never had any symptom of a true hernia, had the vaginal coat of the testicles laid open to cure a hydrocele. After the water was discharged, a soft fat substance, resembling a piece of the omentum, presented itself at the wound. It was gently drawn out and stretched; and no vessels appearing in it, as much of it as the surgeon could come at with his scissars was cut away. The ring of the abdominal muscles and the spermatic cord were of the natural size. No sharp fever or inflammation were raised; but the scrotum became very thick, and of a scirrhus hardness; which was removed by a poultice of hemlock, and repeated doses of mercurial purgatives, and a complete cure was made.

All these four species of hydrocele described above are sometimes seen together, of which the following history may serve as a good enough example.

An old, but otherwise healthy man, had a hydrocele of the third species in the left side, without any manifest cause that he could remember; which became so large and weighty as required an evacuation. He would not allow the sac to be all laid open; but was tapped with a trocar, pushed into the external side of the scrotum, by which more than a pound of water was evacuated; then the thickness and softness of the spermatic cord discovered the œdematous swellings of its other cells. Some months after, he observed the sac filling again; which it continued to do till it was as full as formerly. He delayed having any thing done to it near two years; when all the scrotum, but particularly the left side, was greatly swelled; the teguments were very thick and firm: a fluctuation of liquor, however, was perceived, not only at the superior external part, but at the inferior part, where the testicle could not be felt as it had been formerly; and there was a cross depression appeared externally, which seemed to point out its being divided into two tumours; the alternate pressure of the finger on the lower part did not make any sensible fluctuation in the superior part of the scrotum. The case was therefore judged to be a complication of three species of hydrocele; and that probably the fourth,

fourth, viz. the thickening of the spermatic cord, which had been felt in his former illness, would be discovered afterwards. The teguments were thinnest, and the fluctuation was best felt at the bottom of the scrotum: for which reason the trocar was first put in there, but with some difficulty; and several ounces of water being evacuated, the patient desired any further operation might be delayed. He went abroad some days, then became feverish, with sharp pain towards the lower part of the tumour: He asked no advice for some days more; in which time an evident inflammatory tumour had increased considerably, and the common symptoms of suppuration were begun, which the usual medicines advanced very quickly.

When the abscess was fully ripe, it was laid open by incision; about twelve ounces of pus were let out; and the cavity in which it had been lodged was plainly seen to be formed in the substance of the swelled testicle.—The ulcer was treated in the common way, and promised to cure quickly, the cavity and remainder of the testicle diminishing daily; but the fluctuating tumour in the upper part of the scrotum continued tense, but fluctuating when pressed.—Ten days after opening the abscess, the dressings were observed to be much more wet than ordinary; and when they were taken away, clear water dropped very fast out, and the superior tumour appeared considerably subsided. This watery discharge continuing, the superior swelling went off, and then the ulcer cured; the patient recovered perfectly, and had no more hydrocele.

I have often seen children that were born with a complication of hydroceles, particularly of the first and second species, or who were seized with them soon after birth. They are very easily cured with any corroborants; a bit of flannel, warmed with the fumes of burning benzoin, cures them in a few days.

5. I formerly remarked, that a liquor is frequently found with the viscera in a true hernia; which may be looked upon as a fifth kind of hydrocele. When the quantity of this liquor is small, it is neither in hazard of leading us into a fatal mistake of imagining the disease to be only a hydrocele of any of the preceding species, nor does it require any particular method of cure: but when the water is in large quantity with the viscera, we had need to be careful not to be imposed upon; otherwise, in curing

what we think a simple hydrocele, we may wound the bowels that are in the bag with it.

This kind of hydrocele may be distinguished from the third species, with which it is in most danger of being confounded, by a hernia always preceding it, and by its generally yielding or diminishing when pressed upon, the water in most cases being thus squeezed up into the belly.

If the water in this case is in no great quantity, and without much acrimony, it may be pressed into the belly; from which the medicines proper in a slight hydrops ascites will assist to discharge it. When true herniæ can be reduced without any aperture in the teguments, there seldom is any more necessary: but when the viscera will not reduce thus, the water may either become so acrid, which most frequently happens when the viscera are strangulated; or it may be in such quantity, that we do not choose to trust its absorption from the belly; or the bowels may have blocked up the passage, so that it cannot be squeezed into the belly, while, by its weight, and stretching the parts containing it, it creates great uneasiness and pain to the patient, and is in danger of occasioning disorders in the neighbouring parts. These two last cases are to be seen in herniæ of long standing. All three require the liquor to be evacuated.

Unless when the operation for the true hernia is performed, this evacuation ought only to be made by a small puncture, lest the bowels be exposed and hurt by the air. Instead of directions for making the puncture, I shall relate the history of such a case.

An old man had long laboured under a true hernia, which had not been reduced of a great many years. The tumour became at last of a monstrous size, descending near to his knee, and of a proportional transverse diameter: he was confined to lie on his back; he had very violent pain both in the tumour and his loins, which kept him almost constantly awake; his flesh and strength were much wasted: in some places a plain fluctuation of liquor was perceived with the fingers, without any of the unequal solid substances felt every where else; neither the water nor solid substances could be pushed into the belly. The tumour being pressed so as to make one of those parts, where the fluctuation was most evident and the teguments were thinnest, as tense and prominent as possible, a trocar, as
small

small as a crow-quill, was thrust very slowly through the teguments and cyst: whenever the bag was pierced, the stile was taken out, and the canula was pressed a little forward, through which six pounds of clear ferous water ran out; then the convolutions of the intestines, and the knotty parts of the omentum, were plainly felt, but none of them would reduce. The patient was greatly relieved of his pain, and had no symptom of strangulation of the bowels. No further operation was thought proper; he was allowed to enjoy the happiness he seemed to have by the removal of the violent pain during the short time he had to live.

6. I mentioned observations of Saviard and Le Dran of the hernial sac of the peritonæum remaining unreduced after the bowels were put into their place; the superior part of which being pressed by a truss was greatly straitened, or the sides of it were grown together, while the lower part was filled with water: this may be accounted a sixth species of hydrocele. I never saw this case, nor do I know how it could be distinguished from the third kind which I mentioned, unless the preceding hernia led one to suspect its nature. There is one great happiness, however, that though surgeons should mistake one sort of these two hydroceles for the other, they could do no hurt, the method of curing both being the same.

To finish these remarks on hydroceles, it may not be amiss to give a general caution to all young practitioners in the management of all parts that are made to subside or collapse greatly and suddenly after being violently stretched, especially if the tone of the solids of the patient, or of the diseased part, has been greatly weakened, which is for ordinary the case in hydropic swellings. The caution I would give is, to imitate or supply the effect of the distending cause that is removed; otherwise they may expect that all the weak vessels which were formerly overstretched will be both incapable of preventing a larger quantity than their due proportion of fluids from being propelled into them, and as incapable of making it move fast enough forward; so that, unless when there is a free open outlet or passage for the liquors, the vessels are all over distended with their liquors, which are in hazard of stagnating. In this way the lungs are affected when people die of a peripneumony or asthma, after a sudden discharge of liquor out of the thorax: thus the viscera of the abdomen are

varicous and inflamed after tapping in the *hydrops ascites*; thus inflammations frequently seize the uterus after child-bearing; thus the common teguments, distended by water in the anasarca, or by pus in an abscess, become red, and sometimes mortify soon after a sudden discharge of the liquor which stretched them.—Moderate pressure will prevent the influx of the liquors, and distension of the vessels; and gently stimulating and corroborant medicines will assist the vessels to recover their tone more quickly, which ought therefore to be made use of in such cases.

When, in such a sudden subsiding or collapsing of an over-stretched part, there are vessels opening into any cavities, it may be expected that, for the reasons mentioned immediately above, the open orifices of the vessels will pour out their liquors in more than ordinary quantity, unless the influx of them be prevented by the means proposed in the former supposition, and these orifices be also pressed sufficiently to make them resist them omentum of the fluids stretching them. Thus violent flooding after delivery of a child, is sometimes moderated by pressure on the belly. Thus, when any large abscess is opened, pure pus runs out at first; then it becomes more and more mixed with blood; and at last pure blood is discharged, which sometimes runs out in a great stream, not from any one vessel, but collected from innumerable small pipes opening on every part of the surface of the ulcer; which hæmorrhage stops soon after the cavity is filled with lint, and pressed by a bandage. Hence the necessity of keeping a constant pressure on a distended part, during and after the evacuation of water in a dropsy, or of the pus of a large abscess in weak people. Hence watery tumours laid open send out more liquor in one day than was collected in them for several months while they were shut and stretched. Hence I imagine the hæmorrhage has proceeded which Mr Jamieson (a) tells us happened to a patient of his after opening a hydrocele.

H Æ M A T O C E L E.

BLOOD extravasated after a bruise, wound, tumour, &c. into any of the parts where I mentioned water to be collected in the hydrocele, occasions a tumour which some call *hæmatocele*. Allowance only being made
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(a) Medical Essays, vol. ii. art. 14.

for the different consistence and colour of blood and water, what has been said of the hydrocele may serve also for this ecchymosis.

P N E U M A T O C E L E.

PNEUMA, spirit or air, was made use of by the ancients to account for several phænomena of the animal œconomy, and was esteemed the cause of several diseases: among these the *hydrops ficcus* or *tympanites*, and the pneumatocele, or windy tumour of the scrotum, were as commonly described in books as the *hydrops ascites* or hydrocele; though the writings of observators show those airy tumours to be very uncommon, and scarce ever to be found in the way they are for ordinary described.

Air, escaping out of the *trachea arteria* or lungs into the *tunica cellularis*, may diffuse itself every way, and among other parts may distend the cellular substance of the scrotum and spermatic cord (*a*)—Air blown thro' a pipe put into a hole made in the skin, will distend all the cellular substance of that part, as has been done sometimes to the scrotum (*b*). When there is not sufficient action of the vessels or circulation of the liquors to blend intimately the different particles which enter into the composition of the blood, the particles of air which were restrained from running together, and exerting their expansive elastic power, separate from the other particles with which they were wrought up into the composition of the blood, and being collected exert the common effects of air in any part they are contained in (*c*); and, if they make their way to any part of the scrotum, may produce the pneumatocele. In a scuffle in this city, a man was wounded with a sword in the belly, about half way between the navel and *cartilago ensiformis*; part of the omentum came out of the wound, which was reduced soon after. The patient was exceeding faint, and his pulse very weak. He lived only twelve hours after the wound; in which time his scrotum became as large as his head, with the common signs of pneumatocele. When his body was examined by the surgeons who attended him, the abdomen was found full of extravasated blood, which had come from.

(*a*) Palfyn, Anat. Chirurg. traité 2. chap. 18. Littre, Hist. de l'Acad. des Sciences 1713. Mery, Ibid.

(*b*) Dionis Operations de Chirurgie, demonstr. 4.

(*c*) Littre, Memoires de l'Acad. des Sciences, 1714.

from a wound of the *vena portarum*, through which the sword had pierced. Most of the veins and cellular substance of the abdomen, as well as the scrotum, were distended with air. In some very putrid fevers, small-pox, and gangrenes, I have frequently felt some parts of the skin crackle like parchment under one's finger, and have heard a certain sibilus upon making incisions through it. When carcases begin to corrupt, air evidently begins to generate or separate in the vessels and cavities. From all which it is not unreasonable to conclude, that in a very corrupted state of the fluids the pneumatocele may be formed.

The symptoms of this kind of tumour are commonly described well enough.

When external air is introduced into the cells from the trachea or lungs, or by a pipe; after the access of more air is prevented, that already in the scrotum may be pressed out at incisions made through the skin into the cellular substance, while the bad consequences of the sudden collapsing of the stretched parts may be prevented by the application of corroborating medicines; and it may be convenient to keep up a suppuration in the incisions for some time after, for discharging any remains of the air.

When the pneumatocele depends on internal air, generated or separated from the fluids, the patient must be in very great danger: for such a corrupted state of the fluids, or such a weakened tone of the solids, as is capable of producing this disease, is scarce to be remedied; and air collected in the vessels cannot well be discharged, and must terribly disturb, if not entirely stop, the circulation.

The plentiful use of antiseptic and corroborant medicines is plainly indicated, while the scrotum is treated in the manner mentioned above when we supposed the pneumatocele to be formed by external air.

V A R I C O C E L E.

ANY large tumour in the abdomen, or external force, pressing the veins, or any large tumour of the scrotum stretching the vessels, or impeding the return of the blood, may occasion the veins of the scrotum or the *corpus pampiniforme* to be greatly dilated with blood; which being only a symptomatical disorder, and going generally off when its cause is removed,

moved, needs no particular direction for its cure. But when, by the veins being long distended by such a cause, or if from any other cause the coats of the veins are so much weakened as to yield to their contained blood, and appear in the scrotum tumid and knotty, when the disease is named *circocoele*; or when the *corpus pampiniforme* feels all composed of large knotty strings, which is the more common case, to which the name of *varicocoele* is applied; there is a necessity of using some remedy: otherwise the stretching which the stagnating blood occasions, creates pain, the epididymis and testicle swell, and some species of the hydrocele is in danger of being formed.

A horizontal posture must be of the greatest service in this disease, by which the course of the returning blood is made much more free; whereas, in the erect posture, such a high gravitating column of blood as is in the spermatic veins, without valves to assist in its support, must have very great effect on the lower part of the vessels.—When the patient does rise up, the scrotum, with its contents, ought to be well supported by a proper bandage, to prevent the stretching and pain which the weight of this pendulous part occasions. This precaution of sustaining the weight of weak tumefied pendulous parts, is altogether necessary, and is constantly to be done in all the different tumours of the scrotum.—If there is a general fulness in the vessels of a person labouring under the varicocoele, they need to be a little emptied by the general evacuations and topical astringents, and corroborants are to be applied for recovering the tone of the vessels.—If the varices here give much pain, and threaten to cause some other violent disorder, they may be opened and tied in the way commonly directed. I never saw any varicocoele that required to be so treated.

S P E R M A T O C E L E.

AN excrescence or stricture at the *caput gallinaginis* sometimes makes the *vas deferens*, *epididymis*, and testicle itself, to be greatly distended with the fecerned liquor contained in them; this some writers call *spermatocele*, which is easily distinguished from the varicocoele by those acquainted with the distended parts.

If this disease is recent, the removal of the excrescence or stricture cures it; but if it be allowed to continue any considerable time, it is in danger
of

of degenerating into a scirrhus or carcinomatous tumour, which has a different name given it, to wit, the *sarcocoele*.

S A R C O C E L E.

THE general cause of all the false herniæ of which I have hitherto treated is a liquor distending the different parts in the scrotum. When the solid parts themselves seem to increase, or the fluids lose their fluid and put on a solid form, the name given to the disease is *sarcocoele*, under which several diseases may be comprehended; and therefore I am surprised that some, who have much fondness for the technical terms, have not applied a different name to each of them. Phlegmonocoele, empyocoele, gangrænocoele, scirrhocoele, cancrocele, &c. would have made a fine string of pompous Greek words; and then each of these might have been distinguished according as the disease was in the scrotum, spermatic cord, or testicle. The distinction between phlegmonocoele and inflamatocoele would have been just as proper as what is commonly made between circocele and varicocoele. I am so far, however, from wishing to multiply the terms of art, that, on the contrary, if it was not for the danger of students not understanding readily the books that have been wrote on this subject, I would propose to lay aside the distinction of true and false herniæ altogether, and would use none of the names of the false herniæ which prevailing custom has made me employ, but would call them by the common name the like disease would have in any other part of the body: so that I would have treated of the œdematous tumour of the scrotum or spermatic cord; the encysted dropfy of the spermatic cord, coats of the testicle, or hernial sac; the suffusio of those parts; the varices of the scrotal or spermatic veins; the tumefied excretories of the testicle; the inflammation, suppuration, gangrene, scirrhus, cancer, &c. of the scrotum or testicles.

The different diseases comprehended under the name of *sarcocoele* have the same symptoms and require the same management as the like diseases do in other parts. Having no design to enter upon any account of so many different tumours, which ought rather to be done in a general treatise than in such a confined essay, I shall relate the history of a mortification in the testicle, which I think uncommon; then I shall make some
remarks

remarks on the operation of castration; and shall conclude with another uncommon case, where the castration was performed.

A middle-aged man, soon after recovering from a fever, during which considerable evacuations had been used, was seized with a very acute pain in the right testicle, attended with a quick pulse, for which he asked no advice for some days; during which the testicle, epididymis, and spermatic cord, swelled considerably: after this he was frequently let blood, emollient fomentes and poultices were applied to the part; he was purged with cooling laxative ptisans, and was kept under a strict low cooling diet; but without any relief, except what opium sometimes gave him. At length a fluctuation being felt on the testicle, a train of caustic was laid on the scrotum; and as soon as it had its effect, an incision was made through the eschar into the sac, where about two spoonfuls of thin pus was contained: the testicle being all in view, it appeared of that pale-white colour which it has in dead bodies.

Next day when the surgeon pressed the testicle, the patient was not sensible of its being touched, and the surgeon felt like a fluctuation under his finger; but upon opening the *tunica albuginea*, no liquor appeared; the convoluted fibrous substance of the testicle started out in a very soft pappy condition, and putrid. A considerable quantity of this being cut away with a pair of scissors, the sore was dressed with warm basilicon, with which a few drops of *ol. terebinth.* were mixed, and a poultice of the farines, with some dissolved galbanum, was put over the whole tumour.

For several days after, more of that fibrous substance was cut off, till the bulk of what was brought thus away exceeded the ordinary size of the testicle in a sound man: the parts were well fomented, the suppuration was encouraged, granulated flesh sprouted out from the sides of the cavity in the testicle, the epididymis gradually diminished, the scrotum became thinner; and, in short, the cure went on successfully, without any accident, till the sore was firmly cicatrized. One cannot now know which testicle was diseased, and the patient is sensible of no defect from it.

To perform the castration with the least trouble and dread of hæmorrhagy, pinch up the skin in the groin, and make a large longitudinal incision, by which the spermatic cord may be brought in view; then take up the cord between the thumb and finger of one hand, so that the nails

meet at the back part, upon which pass a very crooked needle with a thread; or rather use the aneurism needle with a handle, and the eye near the point, (see the figure of such a needle, Plate VI. fig. 6.); tie the cord as firm as you can with flat strong waxed thread; put two knots, without any comprefs, between them, and cut off the superfluous part of the thread with a pair of scissars: this being done, cut the scrotum down on the side next to the thigh, and, turning the edge of the skin outwards, stitch the large scrotal artery; after which, the superfluous part of the scrotum, with the testicle in it, may be dissected away with very little loss of blood; only care must be taken not to hurt the other testicle, which will readily come in the way if the assistant-surgeon do not be careful to hold it up in the groin during the operation.—The part of the spermatic cord below the ligature is not to be dissected away from its membranous adhesions, which secure the ligature from sliding afterwards.—By what I saw in four such operations, there is no occasion for cutting the ring of the external oblique abdominal muscle; for there was not any retraction of the spermatic cord after the testicle was cut away in this way I have now described.

The method above proposed, of tying the spermatic vessels, makes the operation of castration much easier than when it is performed as commonly directed: but as the ligature round the cord gives more pain than stitching the artery alone does, and the ligature prevents the efflux of any blood or matter that may be collected in the cellular substance surrounding the spermatic vessels, I now think what Mr Cheselden once did out of necessity (a) should be the constant practice. The spermatic artery ought to be stitched after castration, as other arteries commonly are after amputation.—The late Mr George Lauder being to perform castration where I was to be present, we concerted, that the ligature should be made with a single rose slip-knot, to stop the blood flowing from the spermatic artery while he cut away the testicle and stitched the scrotal vessels: then I loosened the slip-knot: he stitched the spermatic artery with a needle and thread in the common way; but left the ligature loose in the wound, to be ready for tying the spermatic cord, if any of its vessels had bled afterwards. No hæmorrhagy happened; he took out the ligature at the first dressing,

(a) Anat. book iv. chap. 1.

dressing, and the wound cured very soon without the least bad symptom during the time of it.

Neither the common compound suspensory of the scrotum, nor a long swath, are convenient bandages after this operation, for they do not apply neatly; a large compress, broader considerably at one end than the other, with a round hole in the middle of the broad end of it for passing the penis through, and with a large cut in the middle of the narrow end of it to allow the two parts to be folded over each other, ought to be applied over the unmade lint with which the wound is thick covered; and this is to be secured by the two ends of the T or sling-bandage, one tail coming on each side of the scrotum to be fixed to the circular belt, which ought to be double linen or fluff twisted, to prevent its wrinkling into a round cord, which galls the patient.

After the operation, the cure of the wound is the same as of any other common wound.

A young man mounting a horse struck the right testicle against the saddle. The pain of the blow was so sharp that he almost fainted: but becoming soon easier, he neglected it several days; during which the testicle swelled considerably, and the pain increased. The tumour and pain were, however, soon put away by bleeding, purging, and low diet. He continued free of any uneasiness in the testicle several months; after which having rode post some days, the same testicle swelled, but without pain, which made him neglect to ask advice for a year and half, and in the mean time he used much exercise, and lived in a full way. The testicle having then grown very large, he was prescribed pills made of quicksilver and rosin of guaiac with a low diet, which he observed to excess, by which he had the addition of the low nervous symptoms to his other trouble. The bulk of the testicle still increasing, and a fluctuation of liquor being found at the lower part of it, a caustic was applied to the teguments there, and the eschar of it being cut through, some ounces of water ran out, but with very little decrease of the tumour. Soon after, it increased considerably, and he spit some spoonfuls of blood; but as he had no cough, dyspnoea, or pain in his breast, it was doubted whether the blood had come from his lungs or throat. Some time after this he complained of a weight and pain in his loins in making a little journey in a chaise; the-

testicle became larger than a man could contain in his two hands; the lower and posterior parts were as hard as a stone to the touch, but in the superior anterior part a fluctuation of liquor was felt: there was no more space between this tumour and the belly than could allow a man's thumb to be pressed in between them, and in that place the spermatic cord was thick and hard: from the orifice formerly made by the caustic, fungous flesh stood out, which felt as if a liquor fluctuated below; but upon a small lancet being pushed into it, no liquor was found: his pulse was weak and slow, without any symptom of hectic fever: he could take small quantities of broth and weak spoon-food without uneasiness; but from a little while after he had made the sudden change of diet from full living to an excess of abstemiousness, his stomach could not bear flesh or any solid food, so that at this time eating a leg of a chicken made him vomit. His case was judged to be very desperate, but that the only chance he had for life was the extirpation of this testicle; which operation he underwent with great courage and little loss of blood.

The *tunica vaginalis* was grown firmly to the *tunica albuginea* of the testicle at the lower part; but in the superior part was extended into a bag, which contained eight ounces of water: the body of the testicle itself was become a most compact firm scirrhus, with some few begun suppurations in it; it weighed near two pounds.

The patient passed the night after the operation calmly; but would not allow himself to sleep through fear of an hæmorrhagy, the blood having oozed through the dressings in the evening.

He was easy all the three following days, with rather too little fever; only complaining of a certain anxiety, oppression, and faintness, which he scarce knew how to express, but affirmed it was such as made him sure he must die soon, though there was otherwise no bad symptom about him.

The dressings being removed on the fourth day, the lips of the wound were too little tumefied, and the suppuration scarce was begun; some cordial nervous medicines were given him from time to time, and he had syrup of poppies at night.

He was again dressed two days after, when the lips of the wound were rather

rather too thick; the suppuration was begun, the pulse was slow and calm; the wound was well fomented and dressed with digestive.

Next day the swelling of the lips of the wound was fallen, but without a kindly plentiful suppuration; the prepuce and the skin of the penis had a watery thickness in them; and that uneasy sensation which, as I said, he could not find words to express, was greater.

On the eighth day after the operation, the wound looked much better than it had done; his kidneys, his belly, answered well in their evacuation; there was no fault in his pulse; he took food, had no heat or thirst, nor any complaint, except that somewhat which he did not know how to express; and though he called it weakness, yet he moved himself with such agility and strength, that he even joked himself for calling it by that name.

On the ninth day, in the morning, the watery swelling of the penis was decreased, and the suppuration was more plentiful; at noon he eat some chicken, and drank a glass of wine; soon after he was seized with vomiting, then with coldness and fainting, which the strongest cordials did not put away; his pulse sunk, and could not be felt long before seven in the evening, when he died. He remained sensible to the last, and spoke reasonably, and with a strong voice, till within a few minutes before his death, long after his pulse was gone, and his extremities were turned cold.

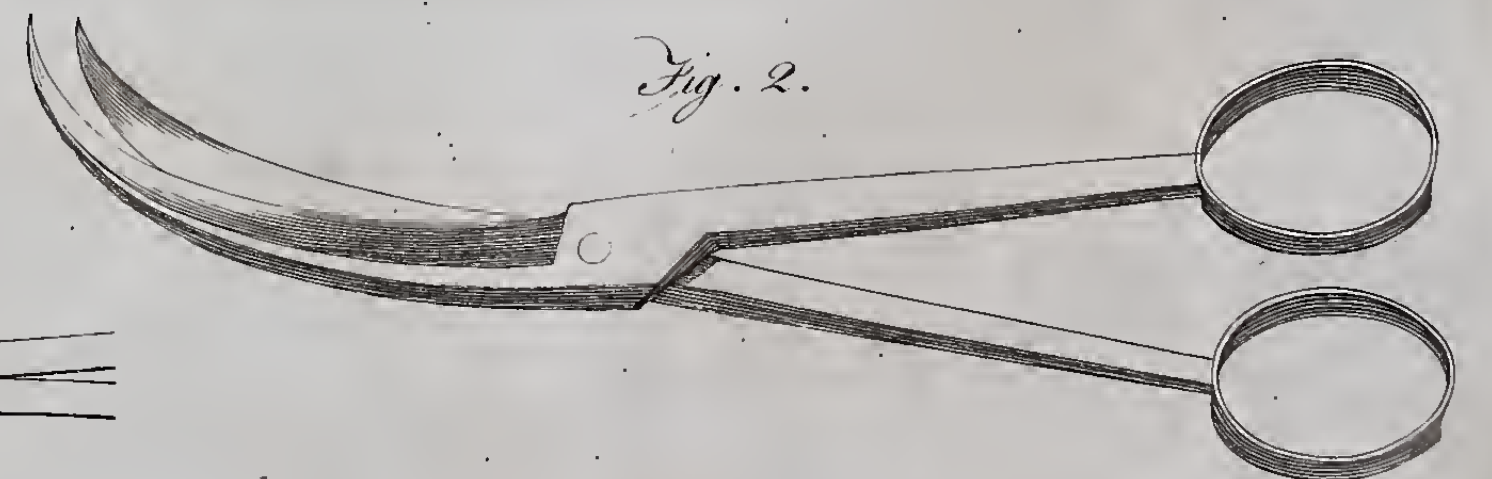
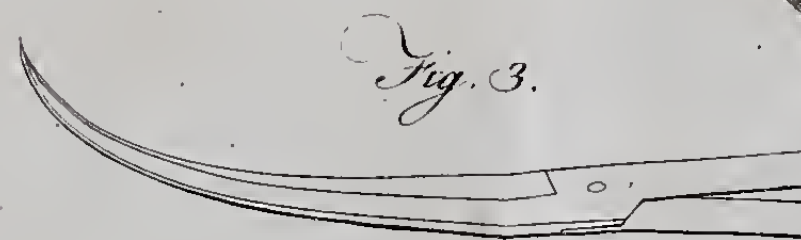
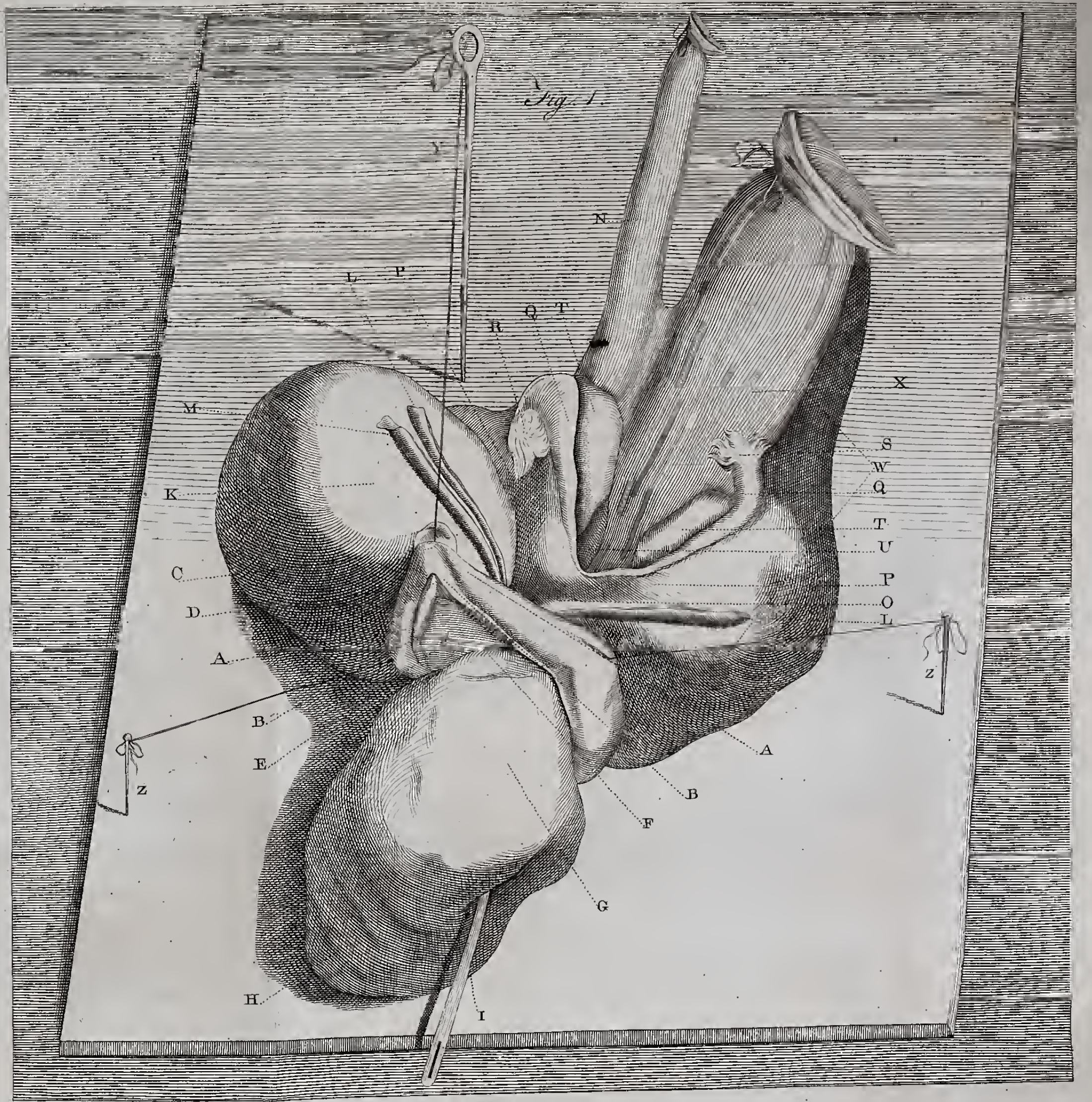
When his body was opened, the mesentery was found inflated with air to a prodigious bulk, as were all the other cellular parts of the abdomen; all the veins, large and small, were in the same condition; the auricles and ventricles of the heart were greatly distended, and collapsed with a great blast of air when cut. There was an ounce or two of pus in the cellular substance, near to the origin of the right spermatic vessels; but below that the cord was found, with the ligature firm on it, lying without the ring of the external oblique muscle. All the other bowels were very sound.

Though in considering the symptoms by which the several sorts of tumours in the scrotum are known, I have mentioned only those proper to each; yet I have here and there given hints, that we are not to expect
these

these diseases always single, but that there often are complications of them, which are to be discovered by the different symptoms belonging to each ; for which reason, and to save repetitions, I did not take notice of all the complications which might happen, and can easily be supposed by any who is acquainted with the structure of the parts, and knows any thing of the simple diseases.



N° 35.



A. Bell Sculp.

N^o 35.

A

D E S C R I P T I O N

OF SEVERAL

CHIRURGICAL INSTRUMENTS.

BEING persuaded that many surgeons are in possession of instruments with which operations in surgery could be done with more safety and ease than with those commonly employed, and that these gentlemen only need to be acquainted how they could make them more generally known to be serviceable to mankind, I send you figures and descriptions of several which I have now in my possession *.

Plate IV. fig. 2. A pair of scissars, the blades of which are crooked in their flat sides. The figure is of the same size with the scissars; but the engraver, not satisfied with this picture's distinguishing them well enough from the common scissars that are crooked in the narrow side of the blades, made the other small figure (3), which shews better where the curve is. This scissars I had from Mr John Douglas surgeon in Edinburgh. They are very useful for taking off excrescences from hollow parts, or for cutting in curve lines, which the common scissars cannot easily be applied to.

Plate V. fig. 1. Is a needle-holder, which I had from the same gentleman. AA two flat flanks or handles, BB the two sides of its mouth grooved for keeping the needles steady, C the hinge, D a spring which keeps the handles asunder, and the mouth open, till the slip-ring or slider E is thrust towards the end of the handles.

This

* Originally published in the Edin. Medical Essays, being Art. xlii. of Vol. V.

This instrument holds the needle more firmly, and its ring slides more easily, than the common needle-holders which I have seen.

Mr Douglas observes, that needles of silver pierce more easily in stitching arteries after an amputation than the steel ones do.

Fig. 2. A bistoury and furrowed director, belonging also to Mr Douglas. A the handle, B the blade of the bistoury, C a button at its point, D the handle of the director, whose groove is hollowed so as all its transverse sections are like to what is represented at E; and therefore the button, once entered at the end of the groove nearest to the handle, cannot come out till it passes out at the other extremity.

In operating with this instrument, a misfortune is surely prevented, which sometimes happens in opening sinuous ulcers with the common bistoury and director, to wit, the bistoury starting out of the groove of the director.

Fig. 3. The blades of a pair of strong forceps, the mouth A of which has on each side two small sharp teeth, which apply close one to another when it is shut. Mr Douglas favoured me also with this.

In extracting bullets, the screw in a canula, which some recommend, cannot be forced into the bullet, unless there is the firm resistance of a bone on the other side; and the blades of the common forceps frequently cannot be introduced so far as the largest diameter of the bullet, without which they cannot take sufficient hold: whereas the forceps here represented can be introduced into a wound safely when shut; and the blades being opened immediately behind the bullet, the teeth piercing into the lead, may have sufficient hold to bring it out, though they be not advanced so far as the largest part of it.

Fig. 4. A trepan given me by Mr Douglas. AA two plates of brass kept together by four pillars of brass BB, C a handle moving a tooth-wheel which turns a pinion, to which G the socket for receiving a common saw-head of a trepan is fixed.

The figure is one half the dimensions of the instrument. The saw will be turned more equally with this instrument than with the hand alone; but whether the rattling or trembling which the wheels make are sufficient to counterbalance this advantage, I shall not determine.

Fig. 5.

Fig. 5. A levator of a depressed skull, which I am informed Mr Petit surgeon at Paris shewed lately in the academy of surgery there.

1. A the wooden handle; B the steel stalk with several holes, in which are female screws; C the lever bended down from the stalk.

2. The *rest*, with its feet covered with leather, and a male screw fixed in the top of its arch, but so as to be moved on a joint.

3. Another *rest* of the same make, but of a higher arch.

4. The instrument with its two pieces joined. This instrument is much preferable to the common ones employed for raising depressed pieces of the skull; the soft feet of the *rest* will scarce bruise the teguments, far less are they in danger of breaking the bone on which they are placed. The force with which the instrument acts can be increased or diminished according to the different hole of the stalk into which the screw of the *rest* is put. The farther from the handle, the longer is the vector, and the more power the hand moving it has. The screw allows the stalk to turn round, and the joint makes it capable of being raised or depressed.

Fig. 6. Another levator, all of steel, given me by Mr Douglas.

AA the handle; B a male screw; C a wood screw; D a runner with a female screw; E a joint, by which the stalk F of the claw, with teeth G, moves on the runner.

Fig. 7. The wood screw C, and the end of the claw G, to shew the claw of a different form, or forked.

When this instrument is used, the claw G is put under the depressed piece of bone; and then the wood screw being fixed into the exterior part of it, the surgeon draws the bone outwards, or to any side, at pleasure.

In some cases, where the direction of the force raising the bone must be varied, this instrument will be preferable to Petit's.

Fig. 8. A scoop for making the perforation into the nose in the *ffistula lachrymalis*, belonging to Mr Douglas.

A the handle, of wood or horn; B the mouth of the scoop, which is made very sharp.

To extract pease, cherry-stones, or such substances, out of the noses or ears of children, Mr Douglas employed successfully the stiff adhesive paste put on the hollow end of a small piece of wood or ivory, with which jewellers draw diamonds out of the lockets in which they are set.

Fig. 9. An instrument for pulling teeth, given to me by Mr James Douglas surgeon to the Welsh Fuzileers ; only that I have added the wooden handle A, where there was a pounce in the one I had from him. B the stalk of steel, C the *rest*, D the claw, E the hinge on which the claw moves.

When this instrument is used, the claw is put on the inside of the tooth to be drawn with its points as near to the roots of the tooth as they can conveniently be put. The end of the *rest* is placed on the outside of the gums ; and a finger being placed above the claw to keep it from sliding, the patient's head is held by the surgeon, who presses down the handle to extract the tooth, by raising the tooth, moved in an arch of a circle, from the socket.

Fig. 10. Another instrument for drawing teeth, given to me by Mr John Fothergill physician at London. A, a gimblet-handle represented too small in the figure ; this I added instead of a small cross-bar of iron. B the stalk, C the convex *rest*, D the claw, E the hinge of the claw.

While the claw is put as in the figure, the instrument can be applied to any tooth in the left side of the lower jaw, and to those of the right side of the upper jaw ; but by taking out the axis, and turning the claw to the other side, it is fitted for applying to the *dentes molares* of the other side of each jaw.

The claw being placed and held down, as mentioned of the preceding instrument, the gimblet-handle is twisted round, so that the convex *rest* is applied to the gum on the outside of the tooth ; and then continuing the twisting, the action of the instrument is the same as of the former.

This instrument is altogether necessary for drawing the posterior grinders, especially in people whose mouth is little, and whose cheeks are thick, where the instrument fig. 9. cannot be applied.

They have both greatly the advantage of the pelican, in so far as their action is not so oblique, and they are much less liable to slide.

A propos of these instruments for the teeth, I must observe, that the pounce has much better effect in pushing from within outwards than in the common way it is applied to thrust the roots of teeth from without inwards : This direction being often to thrust a vault on its convex side, while the former method is acting on its concave side ; and therefore the
stalk

Fig. 1.

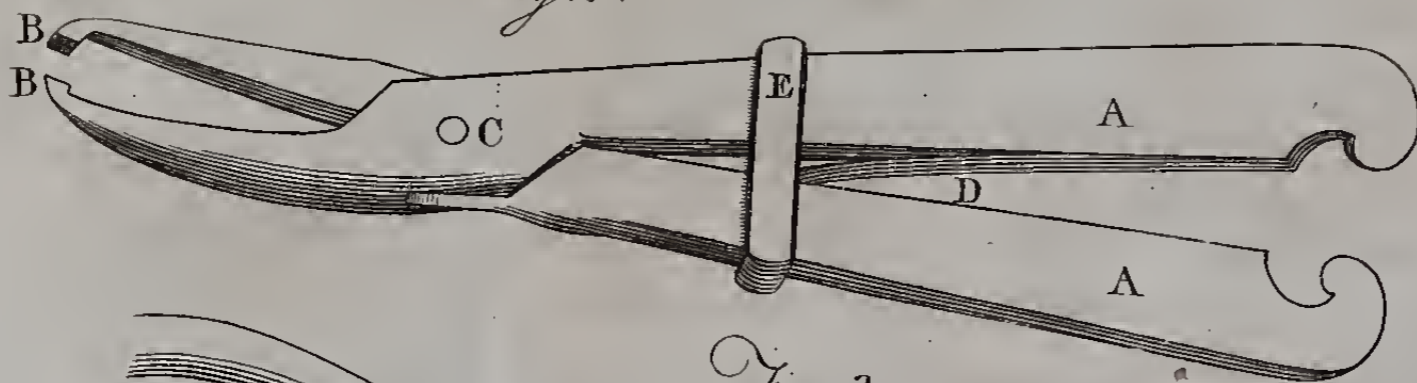


Fig. 3.

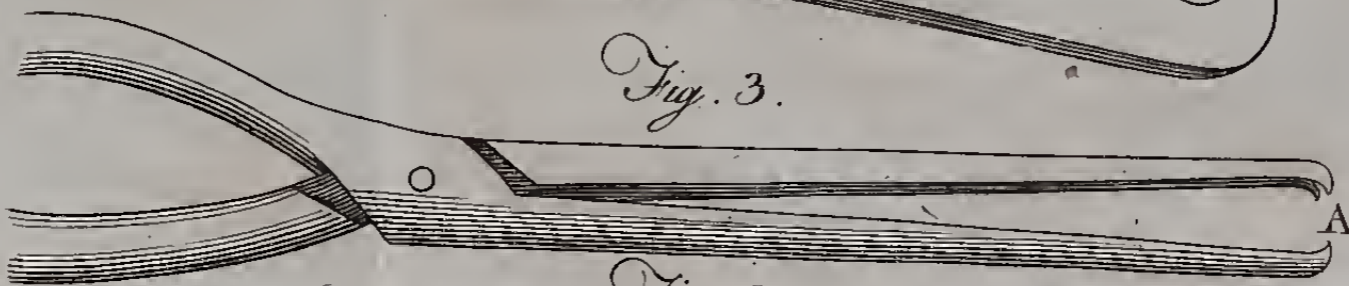


Fig. 2.

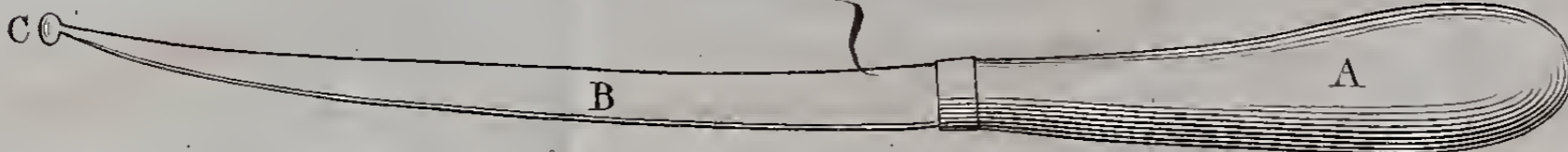
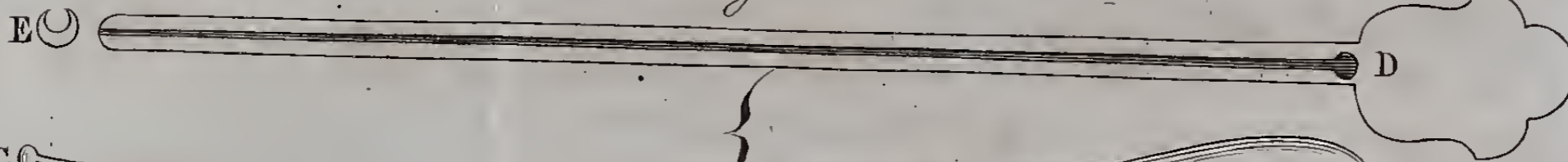


Fig. 7.



Fig. 5.

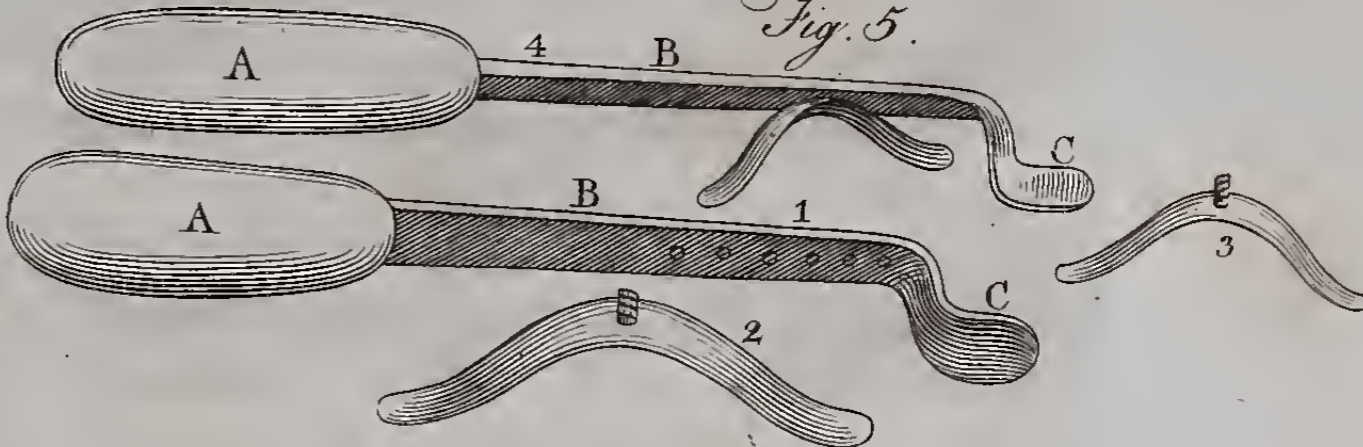


Fig. 6.

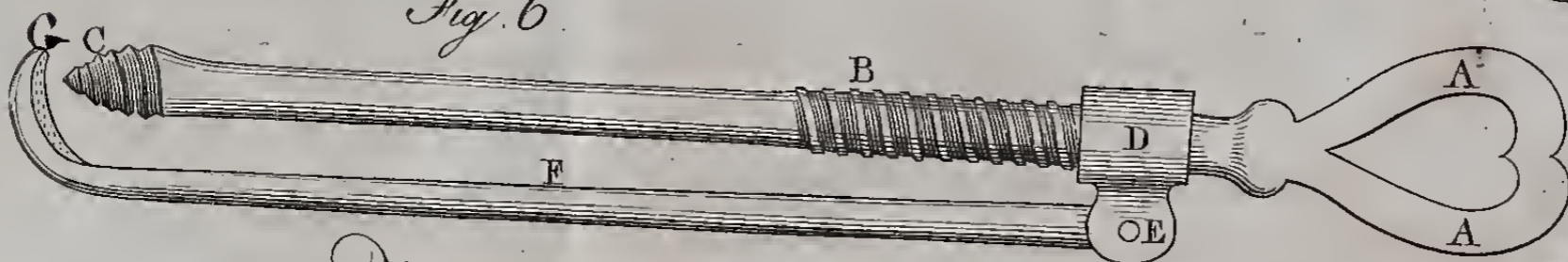


Fig. 8.

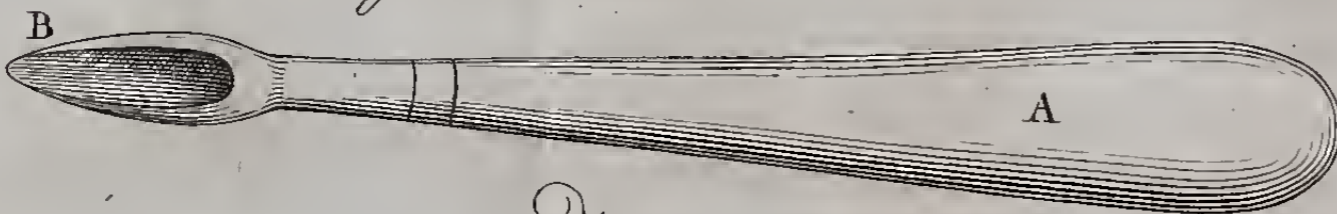


Fig. 9.

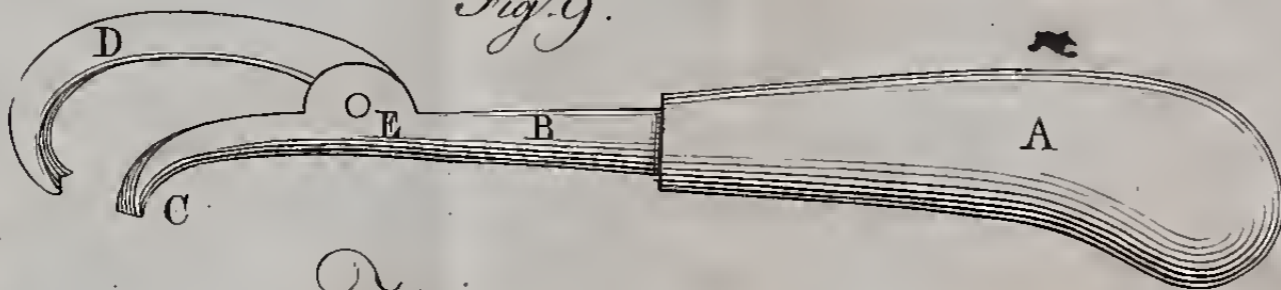


Fig. 10.

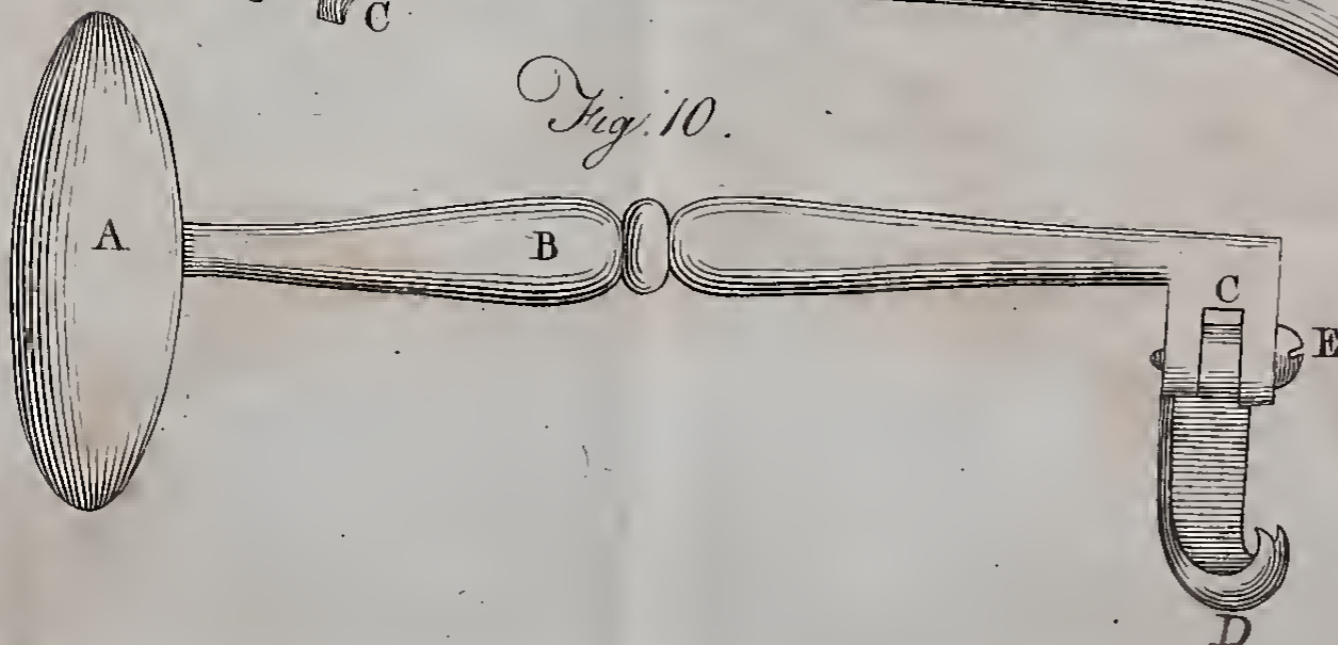


Fig. 4.

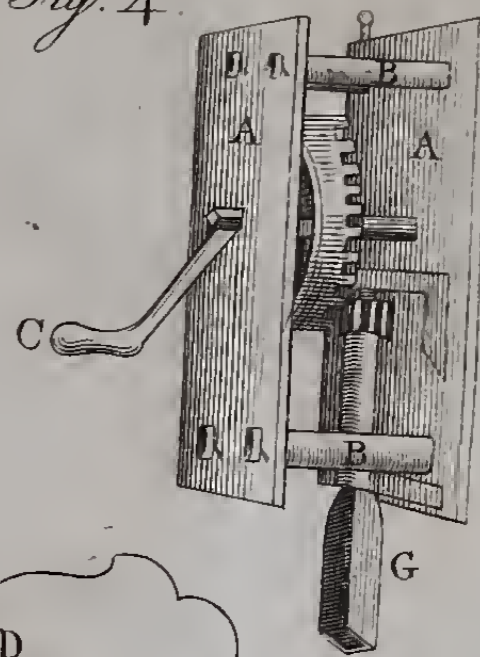


Fig. 11.

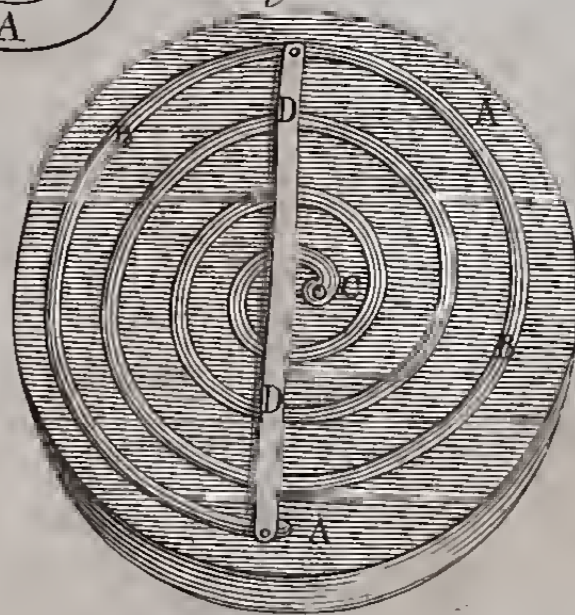


Fig. 12.





stalk of pounces ought to be made longer than they are or dinarily made, that they may be put cross the mouth.

Fig. 11. The anterior view of a bolster for umbilical herniæ. AA, a plate of steel to which the convex stuffed bolster is sewed; BB a raised serpentine spring fixed to the plate AA, at its extremity C; DD a cross-bar of steel to make the play of the spring equal, and to which the circular belt is sewed.

The patient keeping his or her belly distended by retaining the breath, the circular belt is put so tight as to make the spring lie flat on the plate. When the belly is contracted the spring rises, and nearly an equal pressure is kept on the navel during inspiration and expiration, which cannot be done without the assistance of a spring. One disadvantage, however, of this sort of spring, especially in big-bellied people, is its rising too high: For such the spring may be made as in the following figure.

Fig. 12. A bolster for the navel. AA the plate of steel; B a flat serpentine spring, the end C of which is fixed into the plate, and to the other extremity one end of the circular belt is sewed to extend the spring as the belly stretches, the spring contracting as the belly subsides.

Plate VI. fig. 1. A bolster for inguinal herniæ, considerably prominent at A, and thinner at B; the form of it appears better in the lateral view of it D.

The advantages of this form of a bolster has been mentioned in the essay on herniæ.

Fig. 2. A sort of *bistourie cachée* in Mr John Douglas's possession.

A, a narrow bladed bistoury; B and C, two sheaths made of thin plates of silver, between which is a groove wherein the blade of the bistoury can be lodged.

The bistoury, covered with either of them, being introduced into a sinus, the silver sheath is withdrawn, and the surgeon cuts with the bistoury as he thinks fit.

Fig. 3. An instrument for opening *fistulæ in ano* which have an external orifice, but do not open into the rectum, though they run up on the side of it. This instrument was contrived by Mr Adam Drummond surgeon in this place.

A the handle; B the blade, of the shape of a joiner's former; C a nose of elastic

elastic flexible steel, with a button D at its crooked extremity. This nose I added. F a button; H the handle of the directory I, the groove of which is made as that of Plate V. fig. 2.

The furrowed probe or directory being introduced into the sinus, with its groove towards the gut, the button F is entered into the groove at its extremity; and the *former* being pushed forward, its nose is directed into the anus, and the whole instrument is pushed upwards as far as it can go, that is, till its button is stopt by the shut extremity of the groove of the directory, the edge cutting all the parts placed between the sinus and cavity of the gut, without any danger of hurting any part else.

One difficulty I found in using this instrument was its edge not cutting well, because it was only pushed against the parts, without running along to act as a saw does, which is the only way a cutting instrument has a right effect. To remedy this, I would propose to have the edge oblique from E to G, where the button should be put.

But there is still another inconvenience in the use of this instrument, to wit, the nose being stopped by the rugæ of the rectum. A finger placed on the nose, when it is introduced into gut, might however prevent this.

Fig. 4. Another instrument for the same purpose, given to me by Dr Charles Ayton Douglas of Finglassie in Fife.

A the handle; B the blade of a sharp-pointed bistoury; C a thin plate lodged in a narrow sheath E of a directory, the handle of which is D; F a ring; G the cylindrical grooved directory.

When this instrument is employed, the blade of the bistoury is introduced into the sinus with such a sheath of silver as is represented fig. 2. or by putting a probe point of wax upon it, the edge of the blade being placed towards the rectum, into which the furrowed directory is introduced as far as the ring F, which is a stop to it. Then the plate C is brought to slide into the sheath E, by which the point of the bistoury is guided when pressed into the gut to enter the groove of the directory; and, being kept there, the two instruments are drawn out, the blade of the bistoury cutting all that is between the sinus and the cavity of the gut.

After describing two instruments for this operation of laying open sinuses which run upon the outside of the last gut, I must warn young surgeons

surgeons not to be fond of undertaking this operation, especially if the sinus goes any considerable way up, and there is a thick bridge betwixt it and the gut. The reason of this caution is not so much on account of the hæmorrhage which sometimes happens after such an incision, nor through fear of the patient's not retaining the fæces after the cure; for surgeons generally get the hæmorrhage stopt, and the new flesh joins the divided parts of the sphincter so well, that it does its office sufficiently: but I have several times seen a most obstinate diarrhœa come on some days after the operation, which hurried the patients to their graves.

On which account, many years past, I have dissuaded all those who asked my advice for such a fistula, from allowing the operation to be done; and have cured all of them, whose constitution did not require the drain by the fistula, by causing the orifice of the fistulous pipe to be made straight with the pipe itself, encouraging the growth of flesh with injections of digestive diluted with oil, or with such like incarner, and keeping an emollient poultice on the part, without allowing tents, doffils, or probes, to be put into the fore. Under this management several recent sinuses have filled all up, and got a firm cicatrix.—When hope of the parts uniting fails, I then desire drying injections, such as of lime-water, melrose, brandy, and at last of pure alcohol, to be made, that all the sinus may be fully dried and skinned over. Such dry pipes give no uneasiness or trouble, and gradually become much shorter.

Fig. 5. Two views of a steel grooved catheter for performing lithotomy, in a manner a-kin to Celsus's, or upon the gripe, invented lately, as I am informed, by Mr Le Cat surgeon and lithotomist at Rouen. Both figures are one-third of the size which the instrument ought to be made of.

The superior figure represents the instrument when it is to be introduced into the bladder. A, a female head or square socket; BB two rings which serve as handles to it; C the round hollow part of the catheter; D a joint; E its point, where there is a second joint; F a square male head, which can be fixed at any place of the socket by the screw-nail H; G a ring which serves as a handle to the male head, to the further extremity of which a flexible wire is fixed.

The lower figure represents the same instrument, when the male square head.

head is pushed quite down into the socket. A, BB, C, D, E, G, H, denote the same parts which were marked by them in the former figure. I is the flexible elastic wire pushed out by thrusting down the male head F, and raising with it the grooved part L, to which it is joined by a joint at K.

This instrument is introduced into the bladder, when it is as represented in the superior of the two figures, which, towards its point, is nearly of the form of a common silver catheter. Then the male head being pushed down, and consequently the moveable part of the other extremity being raised, as in the lower figure, they are secured in that form by the screw-pin H. The instrument is gently drawn outwards, till the part I, being resisted by the sphincter, as it is called, of the bladder, hinders it from being drawn further out of the urethra, when the instrument is raised up towards the *os pubis* of one side, by which the convex furrowed part L is made to press outwards, and may be felt between the *musculus accelerator urinæ* and *erector penis*: so that the operator, after an incision through the teguments, cuts into its groove, and upon it enlarges his incision, and introduces his conductors and forceps to extract the stone.

Since publishing the description and figure of this catheter, the Royal Society at London has inserted Mr Le Cat's own account of this instrument, in their Transactions, N^o 476. § 11. which differs from the one I gave, in his desiring all from the handle to near the first hinge D to be made of silver, and all beyond that to be made of hard gold; but as he complains of this bending in performing the operation, the steel one is preferable.—The inconveniencies, he says, he found in operating with this catheter, and the death of the three patients who were cut when he used it, will probably make others unwilling to employ it.

Fig. 6. An aneurism-needle, which is fitter for that operation than the common one. A its stalk, fixed into a wooden handle, which is not represented here; B the curve, which is much larger than ordinary; C the eye very near the point.

The handle allows one to hold it firmer; the large curve makes it apply better to the artery, which lies in a cavity; the eye near the point gives occasion for pushing less of the instrument behind the artery; and the

the sharpness of the point makes it easily pierce the thickened membranes, which requires a very strong push of a blunt needle.

Fig. 7. A chisel with which the fingers or toes may be cut off, given me by Mr John Douglas, so often named above.

A the concave mouth, the edge of which is very sharp; B the head; C the handle, standing transverse from the head.

When the common chisels, the stalks of which are long and perpendicular to the mouth, are used, the surgeon is always afraid of hurting his own hand when he strikes with the mallet, and therefore does not probably give such a smart stroke as he would otherwise: and if he does not strike perpendicular, he beats the chisel out of his own hand, misses the right amputation of the member, and bruises himself; all which inconveniencies are prevented when a chisel of the form here represented is employed.

AN UNCOMMON ANGINA.

A MAN, thirty-four years of age, subject all his life to plethoric indispositions, especially in the spring, and to catarrhs when the least exposed to cold, who had not used any fermented drink or heating food for several years; on account of a slight hæmoptoë that had more than once seized him, and had retrenched some of his ordinary diet for near two months, to prevent his vernal plethora; having sat several hours in a chamber without a fire, and with an open window, while the weather was very cold and the air foggy, about the middle of January 1732, complained, as soon as he rose from his seat, of being stiff with cold and very weary, with pains in moving all his muscles, and perpetual yawning: To free himself of the uneasy coldness, he immediately went home, sat near a fire, and drank tea, but could not remove the shiverings and weariness. Upon going into bed, he was seized with the appearance of an aguish paroxysm, which had made a regular course before morning.

Next day he was a little feverish, and still complained of pains through all his body; and therefore took his usual cure in slight maladies of that kind, viz. a laxative ptisan, in which tamarinds and senna had been boiled; which operated gently, and gave him considerable relief.

The day following, he was almost free of all his former complaints; but his right amygdala was swelled and painful, for which the ptisan was repeated.

In the morning of the fourth day, the amygdala was less, and freer of pain; and, except a little bitterness in the mouth, he had scarce any other uneasiness: but, in the afternoon, the left amygdala became painful on the least attempt to swallow; and his pulse turned quick, but not very strong. He was let blood at a large orifice of a big jugular vein, to the quantity of sixteen ounces; after which his pulse became very quick, strong, and full.

full. On this appearance of plethora, eight ounces more were taken away, and the patient then inclined to faint; but in a quarter of an hour after, his pulse was very near as strong and quick as ever. The pain of the left amygdala was so far from being diminished, that it continued increasing; and all the teeth in the same side of the lower jaw, that were otherwise very sound, were also violently and constantly affected; but the pains were most exquisite when he swallowed. In the mean time, he could open his mouth as wide as ever; and nothing preternatural could be observed in his fauces, except a small swelling of the right amygdala, and an erysipelatous redness of the uvula, *velum pendulum*, and left amygdala, without any tumour. After he went to bed, the pains were so racking, especially when he swallowed his spittle, (which he could not possibly prevent doing frequently, whatever care he took to the contrary); that though he is a man who is tolerably patient under pain, he made the whole bed shake with his tremblings, and large drops of sweat appeared on his skin at each attempt. About midnight he could lie no longer; but, putting on his cloaths, he received the fumes of warm water into his mouth; and the pain remitting somewhat, while he endeavoured to hinder the occasions of its violent increase, by leaning his head forward, opening his mouth, and so allowing the saliva to run out, he passed the rest of the night in a drowsy nodding way.

Next morning, his deglutition was performed with great difficulty and pain; and he was so hoarse he scarce could be understood when he spoke, but had no difficulty of respiration; and the fulness and strength of his pulse were less, but its quickness remained. His throat had the same appearance as the night before. The purgative ptisan was repeated. The fumes of warm water were often made use of, and an emollient cataplasma was applied externally on the pained parts.

In the evening, the pain was easier, and the pulse rather better, but the hoarseness continued. A blistering plaster was applied on his neck and back, and emulsion was prepared for his drink.

The plaster did its office well; and the patient, notwithstanding his pain in swallowing, drank two bottles of emulsion in the night, which prevented any strangury till near noon of the following day, when the chamber being overheated, and the patient thereby put into a sweat, the

strangury came on violently ; of which he was relieved, after some hours, by carrying away the fire, and injecting an emollient clyster with turpentine. The emollient poultice was in the mean time renewed ; the fumes of water were frequently applied ; and a mild resolvent gargarism assisted the evacuation of mucus, which began now to be secreted in more than ordinary quantity in the fauces. In the evening, the patient seemed by his pulse to be pretty free of fever, and all his troublesome symptoms were considerably removed.

The blistered parts discharging plentifully the two succeeding days, he seemed to mend apace ; but still continued the poultice, fumes, and cataplasim.

On the third, which was the ninth of his disease, finding in the morning the pain increased, he took the laxative ptisan, and plied the topical medicines ; but through the day the symptoms gradually increased, till, in the evening, his pain in the left amygdala and teeth was rather more violent than ever, the hoarseness was worse than formerly, his pulse was low and quick, he was drowsy, and passed little urine. No swelling could be seen on the left pained side, and he breathed freely. He drank largely of warm posset made with Rhenish wine, and chewed long-pepper with the teeth of the affected side. His urine soon came in great plenty ; he discharged large quantities of mucus at the mouth, and in two or three hours was much freer of pain ; his pulse turned slower, and the dozing went off. The gargarism was renewed, with the addition of some *aq. theriac.* and *sp. nitr. d.* ; and *theriac. andromach.* was added to the cataplasim.

By the use of these medicines, he was greatly recovered in the two following days ; and nothing remaining the third, except a little bitter taste, a trifling swelling in the right amygdala, and a weakness in the left side of the fauces. He went abroad to his usual labour of dissecting in the forenoon, and prelecting in the afternoon ; which he continued to do for a week, using a spare diet and applying the topics ; in which time he got quite free of all uneasiness, except a dull pain of the left side of the fauces, especially in yawning ; and he imagined all the food he swallowed passed only by that side, where sometimes a little of it stopped, and was with some trouble pressed back again into the mouth.

To remove this weakness, the patient one evening gargled his throat with claret-wine and a little *aq. theriac.* mixed. This night he was sensible of a straitening in his breath; and in the morning when he awaked, he was quite hoarse, breathed with more difficulty, and in coughing his head and eye-balls felt as if strongly girded, his face became very red, and he began to hiss in breathing. All these bad appearances went greatly off, after breathing in the fumes of warm water and drinking warm tea. In a few hours after, he swallowed pills, composed of *mercur. d.* and refine of jalap, which operated mildly, and lessened all the causes of complaint considerably; and a second such dose, taken two days after, removed all of them entirely, except a little weakness of the left side of the fauces, and an obtuse pain there in yawning, which remained several weeks after.

In the history of this disease, I have given a strong hint who the patient was; and suspect the common frailty of enlarging on one's own misfortunes may have discovered sufficiently that it is my own case I have related.

What was the particular feat of this anomalous angina? Will the uses assigned to the digastric muscles in a former article (N° 5.) be of use to discover it?

An ASTHMA, with uncommon Symptoms.

MR JAMES URE, whose business as a writer, or solicitor at law, engaged him frequently in company and good-fellowship, was sometimes troubled with a palpitation at his heart, a trembling in his hand, and faintness; being always subject to a cough, and having generally very little appetite for food, with two or three loose stools a-day. In October 1730, the 55th year of his age, having caught cold, a cough seized him, with which he brought up a small quantity of very thick slime, and complained of a difficulty of breathing: he lost all appetite for food, his belly became bound, his urine was in small quantity, and he could not feel his own pulse.

He allowed these symptoms to continue eight days without asking any advice; but finding them continue, and rather increase, he consulted Dr William Porterfield and me, October 20. Besides the above-mentioned symptoms, we observed his difficulty of breathing increase so much upon lying down, that he was obliged to sleep in a sitting posture. His feet and legs were very œdematous. We could feel no pulse in the arteries of his wrist, neck, temples, or ham, but only a sort of trembling under our fingers; which we then attributed to some irregularity in the distribution of his arteries, notwithstanding his affirming, that, when in health, he had a pretty strong pulse in the very parts we felt. The veins of his arm and neck were very large, and stretched with blood. He could take no sort of food; but had a thirst, which was not violent; nor was his tongue dry, or his skin hot. When the cough attacked him, he forced very little pituit up; but his breathing became exceeding laborious, his face turned very red or purple, and he complained of a violent head-ach. When he was free of the cough a little while, he walked, spoke, complained of little, and assured us he was scarce weaker than in health.

To

To prevent the bad effects of the cough, twelve ounces of blood were immediately let: he bled freely, and did not turn faint. In the evening, a terebinthinate purging clyster was injected, which purged him gently. He was desired to take any sort of mild food which his stomach could receive. Rhenish wine and water were given for drink, into which he frequently dropped forty guts of the following mixture: ℞. *Elixir pectoral. unc. i. Tinctur. castor. drach. ii. Sp. salin. aromat. drach. iii.*; and every two hours he swallowed two spoonfuls of the *oxymel pectoral.* of the Edinburgh dispensatory. At bed-time he took this bolus: ℞. *Sperm. cet. scrup. i. Sal. succin. gr. v. Conserv. ros. scrup. i. Syrup. alth. q. s. ut fiat bol.*

Next morning there appeared no change in his condition; and he took *P. ipecacuan. gr. xxxv. Oxymel. scillit. unc. i.* This emetic operated six times without increasing his headach or difficulty of breathing, and brought a good deal of slime with the water he drank. He seemed a little relieved after this vomit, and continued the use of the medicines prescribed the day before. At night a blistering plaster was applied to his neck and shoulders; he took his bolus, and had a cooling emulsion for drink.

The blister rose well; but the pain of it made him so unable to move next morning, that we could not give the purgative we had determined to order. His urine was in larger quantity, with a good sediment; notwithstanding which, his legs were rather more swelled, and the other symptoms continued. His bolus was again given in the morning; he still drank water with Rhenish wine; and he was desired to take frequently a spoonful of the following mixture: ℞. *Aq. hyssop. puleg. a. unc. iii. Cinam. f. v. raphan. compt. a. unc. i. Gum. ammoniac. drach. ii. Sal. succin. drach. sem. Oxymel. scillit. unc. ii. Syrup. alth. unc. i. M.*

He continued much in the same way all the 22d and 23d; only his legs and thighs swelled more, and he began to complain that his cloaths were too tight for his belly.

In the morning of the 24th, he took this purgative bolus: ℞. *Pulv. rhei elect. scrup. i. Aquil. alb. pulv. jalap. a. gr. v. Syrup. de rhamn. q. s. ut ft. bol. capt. e syrup. violar.* This purged him mildly; and the quantity of his urine increased considerably, and his belly and legs became less swelled, which relieved him somewhat of the orthopnoea.

Next

Next day he began to use a medicated wine: *℞. Rad. irid. Florent. scill. acor. ver. helen. raphan. rust. a. unc. sem. Gentian. drach. ii. Rub. tinctor. unc. sem. Cortic. sambuc. ebul. a. unc. sem. Herb. marub. alb. m. ii. Absinth. rom. centaur. min. a. m. Sem. bacc. juniper. unc. i. sem. Sal. tartar. drach. iii. Incis. et contus. f. a. M. ut. ft. malia infundend. in vin. Lisbon lib. vi. Colatur, capt. unc. ii. mane et hora 5ta vespertina.* All this day and the following, his urine passed plentifully, with a large sediment; the swellings diminished, and his cough and breathing were easier. In the evening of the 26th, while I sat by him, he surprised me with putting his wrist into my hand to feel his pulse, which was full, strong, slow, and equal; but two hours after, I could again feel no more than the very weak trembling I formerly mentioned.

The 27th the purgative bolus was repeated. On the 28th, his pulse returned, and continued afterwards firm and strong, till he recovered his former health; which he did in a little time, by the use of the medicated wine, pectoral mixture, and the purgative sometimes repeated.

About a month after, having got the cold again, his symptoms began to return with the same state of his pulse: but upon taking the former emetic and the purgative, they went off; and, to prevent a second relapse, he got strengthening chalybeate medicines, with the stimulating gums, for some time.

In the beginning of January 1732, he was again attacked with the asthma, and want of pulse; which were removed with two doses of the purgative. After a cough, which continued some days in the beginning of February, his pulse could not be felt during twenty-four hours; but it returned after the operation of a purgative bolus.

Soon after my patient retired to the country, where he has continued in very good health; and being lately in town, revised this account of his case, and allowed me to communicate it.

An ESSAY on the JAUNDICE.

WHERE theories are only applied to the resolution of some speculative question, it is of use to expose the false colouring ; but where they are employed to explain the nature of diseases, and either immediately, or by very specious consequences, are introduced to influence the therapeutic part of physic, they ought to be thoroughly examined, that we may either have a valuable truth confirmed, or the world may be put out of the hazard of being seduced by a dangerous error. It is with a view of being serviceable this way, that I propose to examine the causes of a very common disease, the JAUNDICE, which is treated of by the generality of systematic authors in physic in a manner that is capable, in my opinion, of being attended with bad consequences.

One of the most frequent causes of a jaundice is said, by some authors of the greatest reputation, to be an obstruction of the extreme capillary vessels of the liver ; and this obstruction may, according to them, depend on inflammation, scirrhus, pituita, &c. I suspect, on the contrary, that no obstructions in the extreme branches of the hepatic blood-vessels are capable of producing this disease, unless in some particular cases where they may act as a remote cause ; of which I shall have occasion to make mention afterwards.

I would found this negative proof on the nature of all the secreted liquors ; which never appear in the compound mass of our fluids, but only begin to display their different properties after they are separated from the other juices by the discerning organs ; and even then they do not seem to partake of the qualities generally ascribed to them, and by which they are known, until they are farther prepared, and are thrown into some large canals, where their quantity gives us an opportunity of examining them.

them. If, after they are thus fecerned and prepared, they be again mixed with the other liquors, without undergoing some new change in their composition, they do indeed evidently shew themselves by their effects. Since then the particles fit for the composition of any of our liquors cannot be said to enjoy the properties of such liquors, I cannot see why those that enter into the composition of bile should be supposed to produce the effect of bile, without having been ever separated. We see plainly, on the stoppage of the secretions of other liquors whose colour, smell, and taste, are capable of making us distinguish them, that they do not seem to shew themselves in their natural form any where else. Thus, for instance, in an hydropic person, whose urine is suppressed by the compression or obstruction of the vessels of the kidneys, and whose belly and *tunica cellulosa* are thence greatly distended, we do not find that the waters extravasated into these cavities have the real marks of urine in them; nay, in the discharges of the skin and kidneys, which are so succedaneous to each other, we cannot observe urine drilling through the skin, nor any thing like sweat in the liquor discharged from the bladder. From these, and other such examples, I should imagine an obstruction of the blood-vessels of the liver, considered only as such, to be incapable of mixing bilious particles with the other fluids that are to circulate through the whole system of vessels; and therefore incapable of producing a jaundice.

But seeing reasoning *à posteriori* is much more convincing in such matters than any other, I would next observe, that if particles fit for composing bile were supposed capable of producing all the effects of bile, it would then necessarily follow, that whenever such particles were sent in large quantities from the *vena portarum* into the *vena cava*, a jaundice would be formed; consequently this always would happen when any considerable obstruction is made in the liver. Daily practice, and heaps of observations handed down to us, shew, however, that violent inflammations and great abscesses have been in the liver, and that the whole bowel has been scirrhus, without any appearance of a jaundice. The examples are so numerous, I need not quote authors: See only Bonetus's Collections. The conclusion, therefore, that necessarily follows from these

these facts, is in the negative to the allowing obstructions to be an immediate cause of the jaundice.

It may be alleged, that hitherto I have too abstractedly considered obstructions as a stop put to the passage of the liquors through the extreme vessels; whereas I ought to have had regard to the necessary consequences of such an obstruction, which it may be thought would solve all the phenomena upon my own principles. These consequences are the distension of the obstructed canals, and the compression they must make upon the adjacent parts; among which there must be several that contain the bile that has been secreted, which will therefore be forced back again into the blood-vessels to occasion a jaundice.

That I may give my opinion distinctly on this subject, it will be necessary to consider the different parts of the liver where such an obstruction may be seated.

If the obstruction is made in the concave side of the liver, in parts situated near to the large biliary ducts, and if the swelling is very great, I shall allow it may stop the passage of the bile into the gut, and so may serve as a remote cause of the jaundice. I am not however convinced, that this effect will follow from the compression of the hepatic ducts, unless the cystic bile be also prevented from flowing into the duodenum. My grounds of doubting whether the hepatic bile can occasion this disease, are the following. Both by the taste of the liver at some distance from the gall-bladder, and by trials made of the hepatic bile when collected, we plainly find it to be a very mild liquor, with a very small proportion of the proper bilious particles. Next, we see most of the drains of the body capable of transmitting bilious particles along with their other fluids: Thus the spittle of icteric people is bitter; and their urine, and sometimes their sweat, tinges linen yellow. Lastly, the quantity of bile constantly refunded to the mass of blood along with the finer parts of our food is considerable, and probably some of it has not its composition changed by the force of digestion; yet there is no appearance of its mixture in a natural state. From these observations, one would be apt to suspect the bilious lymph of the liver to be capable of gradually mixing with the blood, without manifesting itself, especially since it can so quickly be sent out of the body by the excretories; nay, though this should not happen,

we can scarce suppose such a high colour, strong taste, and violent effects, so quickly produced by the hepatic bile, as is daily seen on the first discovery of the jaundice. To these arguments might be added the deficiency of proper observations or experiments to prove the jaundice produced without the cystic bile.

When obstructions of any kind occasion a tumour any considerable way within the liver near the branches of the *porus biliaris*, it may in part stop the course of the bile in these branches, from which it may be taken up by the ramifications of the *vena cava*: But the consequences of such bile will be of so much less effect towards creating a jaundice than in the foregoing supposition, as the quantity of bile hindered from flowing to the common duct is less; and, in confirmation of this not being an adequate cause to produce this disease, we have numerous examples of tumours of all sorts observed in the liver upon dissection of bodies that had no icteric sign.

In respect of both the suppositions I have made, it is to be remarked, that a considerable tumour must be formed, before the sides of the biliary canals inclosed in their ligamentous sheath can be compressed sufficiently to have the effects which I have granted; and when the tumour is large enough, it must first straiten the branches of the *vena portarum*, which are larger than the contiguous biliary ducts: therefore, before these suffer, the quantity of bile secreted must be much diminished; and if the lessening of this liquor is in the same proportion with the straitening of the vessels, the bile will pass; if the ducts cannot transmit all of it, the quantity interrupted will be but small, and its effects will be little.

The last supposition necessary to make, is the obstruction of the vessels remote from the larger biliary ducts, where, the tubuli being small, a less distension of the obstructed canals will have greater effect on them. From what has been already said, it will seem at least necessary to suppose the obstruction pretty universal through the liver, in order to obtain such a consequence as is commonly disputed for. But then it is also obvious, that the obstructed vessels are the very canals that ought to supply the liquor which is to be secreted; and therefore the secretion will be prevented, which is also brought about by the compression which the tumefied vessels make on the small tubes from which the biliary canals rise,
that

that is, on the fecerning organs themselves. If then there is any truth in what I argued for, of unsecerned particles, which might prove proper enough materials for composing bile, not being capable of causing a jaundice, though they continue mixed with our mass of blood, it will follow, that neither on this third supposition will a jaundice be produced. Nor will it be amiss to support this reasoning, by repeating the mention of the many examples recorded of the liver being entirely scirrhus or suppurated, without the persons ever having a jaundice.

This view of obstructions in different parts of the liver, give, I imagine, some reason to think such a cause unfit to produce a jaundice, whatever other bad effects such obstructions may have in disturbing the animal œconomy.

Whatever fate attends the doctrine of obstructions of the liver, must affect the practice of curing the jaundice; and if this disease is so far from having obstructions for a frequent cause, that they cannot occasion it, then *deobstruent*, *aperient*, *resolvent*, &c. medicines, and their different classes, adapted to the particular nature of the obstructing matter, will appear to be rather contrived for removing or mitigating some concomitant symptoms and palliating some effects of the jaundice, than designed to make a radical cure of the distemper.

By what has been above hinted, it will be readily conceived, that the only cause I would argue for as capable of producing a jaundice, is the stopping of the bile in the *ductus communis choledochus*, or in the cystic duct, and perhaps in the hepatic ducts of some few persons whose hepatic bile is much stronger than it commonly is found.

Such an obstruction may depend on a great variety of causes, such as large tumours or abscesses in the concave part of the liver, or in any other parts in the neighbourhood of the large ducts; violent inflammations, or other tumours, in the course of these ducts; the growing together of their sides; violent spasms in the duodenum, by poisons, or in the hysterical disorders; very great inflammations and distensions of that gut, which often have the appearance of colics; and principally stones or concretions falling down from the gall-bladder.

Practical anatomists sufficiently show, how frequently concretions are to be found here; scarce any of those who have handed down what they ob-

served in dissecting human bodies, have omitted to give histories of this kind. Only remark what a great variety are described by Morgagni (a): And, in another book, *Bonetus's Sepulchret. Anat.* we read a collection of numerous examples of this disease, the jaundice, proceeding from this cause, stones; and several of the greatest practisers in physic have taken notice of stones passing commonly when the jaundice was going off. On these accounts it is surprizing, so little regard is had now-a-days to these concretions, in the ætiology and cure of this disease, as to find them mentioned only *en passant* as a possible cause, without any directions to endeavour their expulsion in completing the cure; which I can only attribute to their being passed unobserved, because of the troublesome disagreeable office of searching for them.

Let us with all this consider, how exactly the falling down of a stone from the gall-bladder into the duct, explains all the phænomena that commonly happen in the jaundice, which no other cause will do, and we shall have reason to look on concretions as a much more frequent cause of this disease than is generally thought. If a small stone falls into the duct, a considerable share of the bile may still pass; and, though the patient's urine becomes higher coloured, the skin remains untinged; the gall-bladder gradually is filled with bile, which gives a sense of weight in the right hypochondr; the secretion is diminished in the liver by the greater resistance now made to the evacuation of the bile; and the quantity of blood returned to the *vena cava* is greater, which makes a fulness in all the vessels of the body, giving the sense of repletion and lassitude, with an inclination to sleep. When a large enough quantity of bile regurgitates, the jaundice appears; and, according to the change of situation of the stone, the disease will have remissions or increase. If the concretion is so large as to press on the sides of the duct, it occasions pains about the lower part of the stomach. If the irritation it makes is great, the pains become more acute and lancinating; and the stomach sympathizing, as in the *calculus renum*, the patient vomits. If this irritation continues, the part where the stone sticks will be inflamed, and the neighbouring parts soon come also to be affected. By the inflammation and pain, a fever may be raised. When the stone obstructs the duct entirely, the
excrements

(a) Epistol. Adversar. Act. Physico-medic.

excrements cannot be tinged yellow; nor will the intestines do their duty, because of the defect of bile, which, being reassumed into the mass of blood, tinges the urine, skin, eyes, &c. When the stone falls quickly into the duct and totally obstructs it, the person becomes suddenly icteric. If the stone is soon pushed forwards into the intestine, the disease is as soon removed by the passage of the bile being again free. If more stones succeed each other soon, the disease will appear to have had remissions. If there is any considerable interval between their falling down, so many periodical returns will be made of the disease. A diarrhœa often cures this disease, or rather a diarrhœa is the consequence of the cure; for as soon as the concretion falls into the gut, the bile that was dammed up follows in a great stream, and occasions the diarrhœa, at which time the stone or stones will be found among the fæces.

Concretions not only exactly thus account for the appearances of the jaundice, but by them only the effects of several plain antecedent causes can be understood. This disease, for example, has been brought on by violent anger, riding, reaching to vomit, fits of an ague, and several other convulsions or agitations of the body, which we cannot imagine to be any other reasonable way produced, than by a stone's being pushed down by these shocks of the body into the duct from the gall-bladder, where it lay floating before. Which leads me naturally to think physicians frequently liable to be deceived, when they suppose spasms, inflammations, colics, acrid ingesta, &c. bringing on a jaundice, by the sole constriction of the biliary duct, without the help of any concretion: for in these cases, either the causes could not be so permanent, *e. g.* the spasms would not continue so long as the disease does; or these causes seem not capable to bring on the disease so soon after their own appearance, such is the inflammation; and if the disease was owing to several of the causes mentioned, it would not go off so soon as frequently it does. It is much easier, therefore, to conceive, how such forcible causes bring down a concretion, which proves the immediate cause of the disease.

If then stones are found most frequently to give rise to this disease, without the accession of any of these other causes which I have accounted capable of producing a jaundice; and if these other causes are so well fitted for bringing down loose concretions, so often to be met with in the gall-

gall-bladder; it will follow, that the first thing a physician ought to consider, when called to an icteric patient, is, whether any other cause manifestly shews itself without any indications of a stone; and according to the particular nature of that morbid cause, he must prescribe: but if either the symptoms of a stone's being engaged in the biliary passages are blended with the others, or if there is not evident reason for not suspecting stones to have any share in occasioning the disease, which seldom will happen, particular regard is to be had to such concretions in the indications of cure.

I know it has been objected to the notion of bilious concretions so often producing a jaundice, that in icteric bodies no stones have been found in the ducts though sought after, and in other bodies stones have been seen fixed in the ducts without any preceding jaundice. To the former objection, it may be answered, that I have already allowed other causes to be capable of giving rise to this disease; and many cases can be supposed, where, though stones occasion it, yet we cannot expect they should be found. To name one instance among many, if an exhausted patient should die by the diarrhoea, which so frequently comes on when the concretions drop into the gut, it would be in vain to expect to find them. The other objection will as little prove what is intended by it, unless several other particular circumstances are accurately observed; as, for instance, If the stone was lodged in the duct long enough to occasion the disease, or if it has been only forced down by the agonies of death: If it is large enough, and so situated as to hinder the course of the bile; or if it still might allow this liquor to pass: If the liver is sound, and fit to secrete good bile; or if it is otherwise diseased, and has either performed little or no secretion, or has separated a liquor different from bile. For if these circumstances come out in the latter of the alternate ways I have proposed them, this observation will have no weight as an objection.

But to return to the method of cure: I have already given reasons why I think physicians are to act, in far the greater number of icteric cases, with a view to stones that are to be expelled: and this will still appear more necessary upon reconsidering the other causes, several of which do not admit of a cure, or at most we can promise very little upon our success in treating them; such are all large tumours situated near the great
biliary

biliary ducts, poisons, &c. If these therefore are cut off, and if most of the other causes do not distinguish themselves sufficiently from concretions, it will not be thought improper to affirm, that jaundice ought to be treated, rather more than can be said of any other disease, with one general indication of expelling stones; and the spasms, inflammations, tumours, &c. are only to be looked on as so many concomitant symptoms, to which regard is indeed to be had in the management of the patient, while the main indication is to be pursued; and medicines are to be applied in very near the same form and intention as are used in cases of stones lodged in the ureters, which bear a very strong analogy to the subject which I have just now treated of.

N^o 39.

DESCRIPTION AND USES
OF THE
INTESTINUM DUODENUM.

ANATOMISTS having generally copied Vefalius's (*a*) description and picture of the *intestinum duodenum*, which appeared to me very faulty, I caused the engraver draw that intestine in its natural situation several years ago *. Since that time, I have read two authors, Santorini (*b*) and Winslow (*c*), who have described this gut more accurately than Vefalius: but neither of them having given any figure of the parts, and my description differing considerably from theirs, as will appear upon comparing them, I resolved to send you this paper, that the exact situation of this intestine might be more generally known; by which many phænomena in the animal œconomy and diseases may be understood and explained.

From the pylorus, which is raised upwards and backwards from the stomach, the duodenum descends obliquely to the right side, with the anterior lamella of the omentum fixed to its inferior part, and the little omentum proceeding from the opposite part to connect it to the liver. After this, the duodenum is involved for about an inch and a half in a doubling of the omentum, and then enters into the duplicature of the
mesocolon,

(*a*) De Corp. Hum. Fabric. lib. 5. cap. 4. (*b*) Observ. Anat. cap. 9. sect. 7.

* Originally published in the Edin. Med. Essays, being art. xi. of Vol. IV.

(*c*) Exposition. Anat. traité du bas ventre, sect. 105. &c.

mesocolon, where it cannot be seen without dissecting away that fatty membrane. It descends in this cellular sheath till it is almost contiguous to the great sac of the colon, which properly is the human cæcum. In this descent the colon lies before it; the biliary duct, hepatic artery and nerve, *vena portarum*, and emulgent vessels, are behind it; the liver, gall-bladder, and right kidney, are on its right side, and the pancreas is on the left. This gut makes several turns in this progress; for it is raised into a convexity forwards, where it passes before the vessels of the liver. Immediately after, it bends backwards, and to the right side, till it approaches the right kidney; and then turns forward, and a little to the left, in its course towards the great sac of the colon. The duodenum then makes a considerable curve to the left side, where it is involved in a cellular substance, which may be looked on as the common root of the mesentery and mesocolon, through the membrane of which it may be seen commonly, even in very fat bodies, without any dissection. In the concave left side of this curve, the thick extremity of the larger pancreas and the little pancreas are lodged; the superior mesenteric artery and vein coming through the notch between the larger and lesser pancreas hang loose before the gut here; and the *ductus communis cholidochus*, after passing behind the gut a little higher, unites commonly with the pancreatic duct, very little above the lowest part of the curve; and after passing obliquely through the coats of the gut, the two ducts open by one common orifice in the posterior part of the duodenum. After the curve just now described, the duodenum is involved in the root of the mesentery, and mounts obliquely within it towards the left side, with the *vena cava* behind it; and after a course of about four inches there, rises forwards, to acquire a proper mesentery, or to commence jejunum; the membranes of the root of the mesentery seeming to make a ring at which the gut comes out, though they are really continued on the intestine, and form its external membranous coat.

That the duodenum may be all exposed to view, without changing its natural situation in a body lying supine, it is necessary to cut through the great arch of the colon below the bottom of the stomach; and after turning the cut extremity of the left side over on the left short ribs, to take hold of the other extremity of the colon; and having separated it with a

pair of scissars from the stomach and liver, taking away with it as much of the omentum and mesocolon as obstruct the view of the duodenum and pancreas, to lay it likewise on the right loin. When the colon is removed, observe where the roots of the mesentery and mesocolon cover the duodenum so much as to prevent your seeing its course: at such places cut these membranes with a very sharp scalpel, directing the incisions according to the length of the gut, and then cautiously separate the membranes to each side, till all the intestine is in view. Lastly, draw the small guts gently down, raise the liver, and suspend the fundus of the stomach as much as is necessary to allow a full view of the whole course of the duodenum.

Those who have ever dissected the human body, must be sensible how difficult it is to lay the duodenum of an adult all in view, without disturbing its situation; and the task of keeping all the parts in the same fit posture till a painter delineates them, is still much greater: Therefore, though the preceding description is taken from the adult body, I chose to lay the body of a foetus, which I had preserved several years in acidulated spirit of wine, before the engraver, to draw the picture from; and afterwards I compared this picture with several adult bodies, to make sure of there being no essential difference.

In Plate VI. fig. 8. are represented,

AA the liver, larger proportionally than in the adult, and raised so that its concave side is in view.

B The umbilical vein entering the liver.

This vein is commonly described and painted as passing to the *vena portarum*, without sending off any branches: but in all the human foetuses or young children which I have dissected, after their vessels were injected, I always saw the umbilical vein giving off vessels to the liver, in its passage through it towards the *vena portarum*.

C The gall-bladder full of bile, of a more pyriform shape than it is for ordinary in an adult.

D The stomach distended with air.

E The remains of the omentum.

FF The extremities of the divided arch of the colon laid to each side.

G The

G The pylorus where the duodenum begins, and the little omentum connects it to the liver. From this to H it is covered by the omentum. Between H and I this gut is lodged in the cellular substance of the mesocolon, thence to K it is covered by the common root of the mesocolon and mesentery. It runs involved in the mesentery to L, where there is an appearance of a ring; but instead of being turned down afterwards, as here represented, because of the guts being drawn so much down to have a full view of the duodenum, this gut makes the curvature delineated in fig. 9.

M The large pancreas with its duct, which is more hid by the stomach in an adult.

N The little pancreas with its duct.

O The meseraic artery and vein cut as they pass in the niche between the larger and lesser pancreas.

P The *ductus communis cholidochus* appearing on the left side of the gut, where it is about to join the pancreatic.

Q The right kidney.

R The small guts.

From the description of the duodenum, it must appear, 1. That since it is involved in the cellular fatty substance of the omentum, mesocolon, and mesentery, without having the firm external membrane braced upon it as the other guts have, it must therefore more easily yield to any distending force: and having the whole substances thrown into the stomach with the bile and pancreatic juice poured into it, it must receive more than any other intestine; and then whatever enters it must go out with some difficulty, because its extremity next to the jejunum is fixed in a course almost perpendicular upwards. So that, upon the whole, it is no wonder that this intestine is frequently found of so much larger diameter than the other guts, as to be called *ventriculus succenturiatus* by several authors.

2. The ascending course of the extremity of this gut, and the influx of the bile and pancreatic liquor into the most depending part of it, where the food must make the longest stop, are wisely contrived, both for the more easy influx of these liquors, and for a sufficient quantity of them

being mixed with the food, to perform well the necessary offices for which they are designed in digestion.

3. A pendulous intestine here would, in our erect posture, have drawn the stomach out of its due situation, and might have twisted or over-stretched the biliary and pancreatic ducts, so as to have stopped the course of the liquors in them; and therefore it is so firmly tied down in its whole course, that it cannot change its situation.

The duodenum of brutes is likewise placed in such a manner as to answer the same useful purposes; though in many of them this gut would appear to one who does not consider the different postures and way of life of animals, to be situated in an opposite manner to the human body. To show how general this contrivance is, I shall cursorily mention a few examples.

Apes, whose posture is for most part erect, or nearly so, have these parts disposed in nearly the same way that man has.

In dogs, cats, cows, sheep, and most other quadrupeds whose posture is horizontal, the pylorus and beginning of the duodenum are firmly connected to the liver; after which a considerable piece of gut, with a mesentery, hangs pendulous, and then the gut is fastened to the loins and back-bone; therefore the pendulous part must be lowest in them. The biliary duct opens into the duodenum where it is tied to the liver. The pancreas is long, and lodged in the mesentery along the pendulous gut, and its duct is near the middle of that gland.

Hens, ducks, geese, and other fowls, whose posture of body is neither erect nor horizontal, but oblique, have the beginning of the first small gut well secured to the liver, from which the gut runs near to the poudex, and returns again to near the same place where it began at, to be again tied to the liver; all between these two connections being pendulous. The pancreas is fixed between these pendulous parts, and its ducts open into the part of the gut where it had returned back to the liver, as the biliary ducts also do, but with a direction opposite to the course of the aliment in the gut. After the entry of these ducts, the intestine runs a good way along the concave part of the liver towards the membranous diaphragm, being fixed to the liver and to the air-membrane which lines
the

Fig. 1.

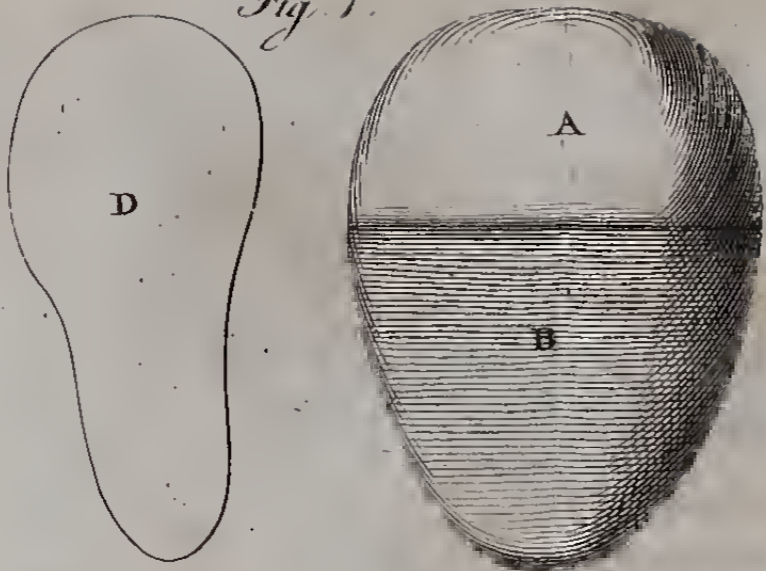


Fig. 2.

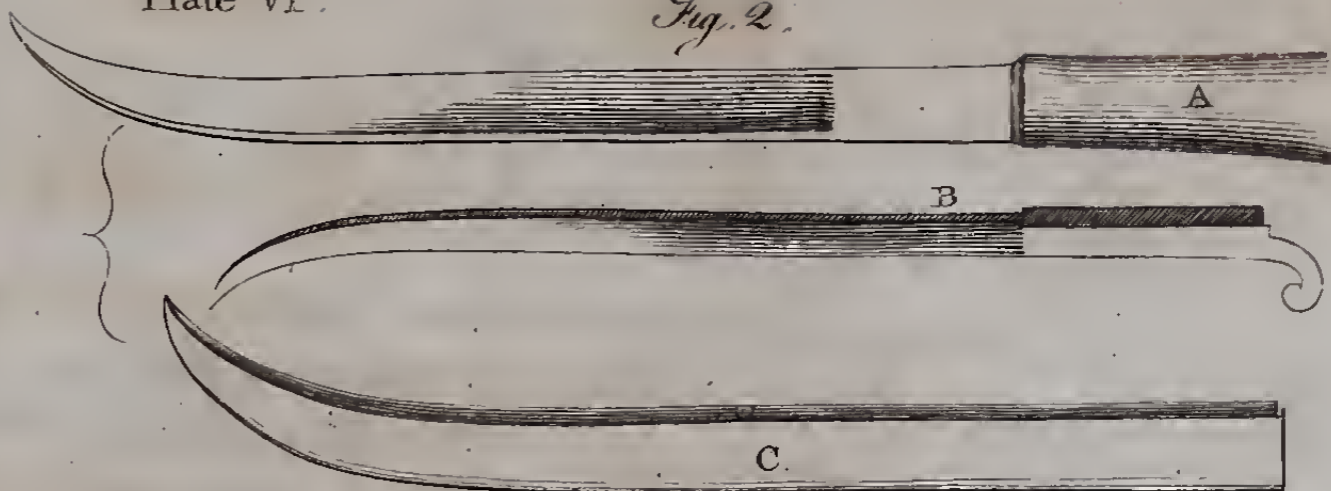


Fig. 3.

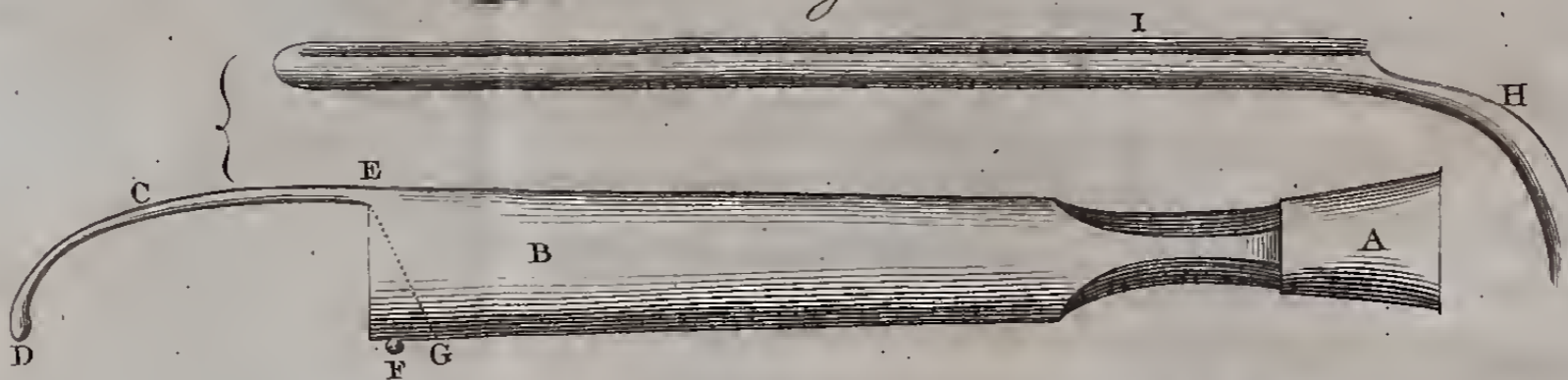


Fig. 5.

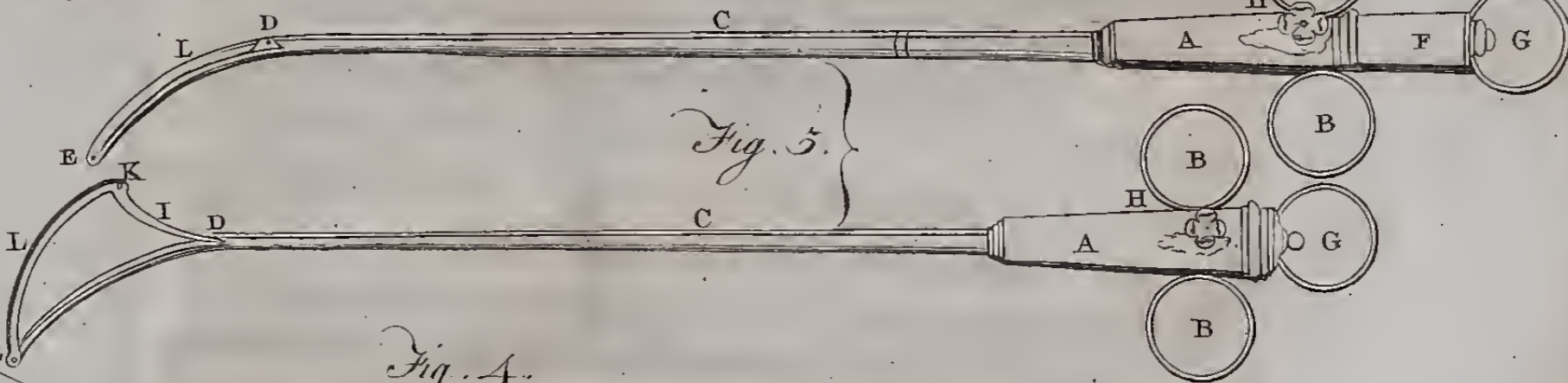


Fig. 4.

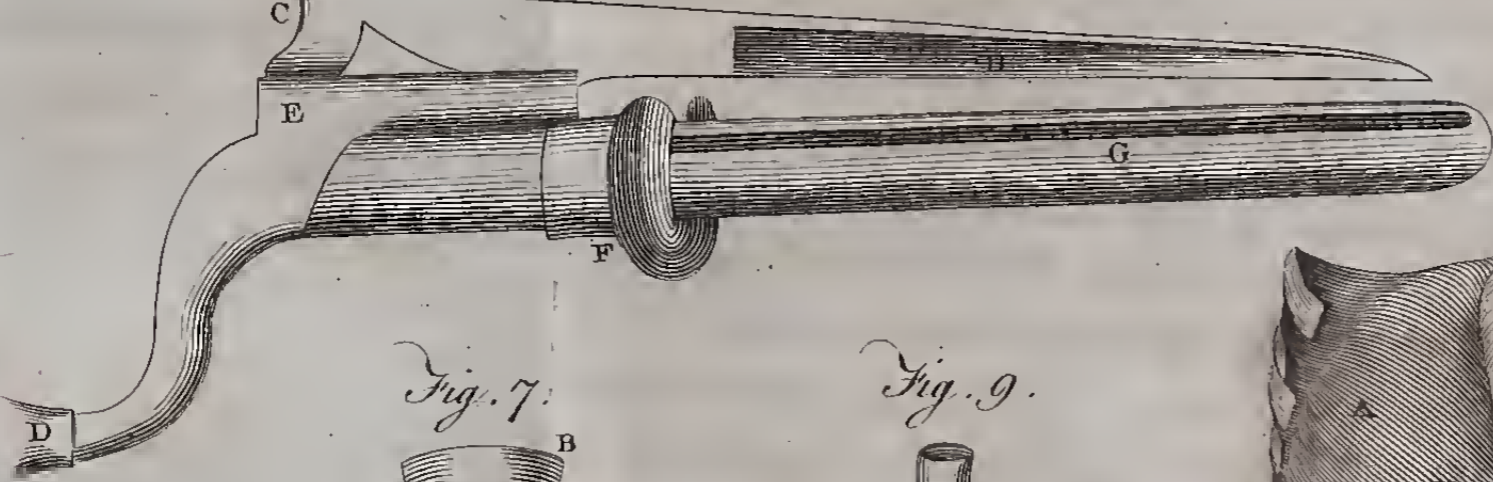


Fig. 7.



Fig. 9.



Fig. 6.

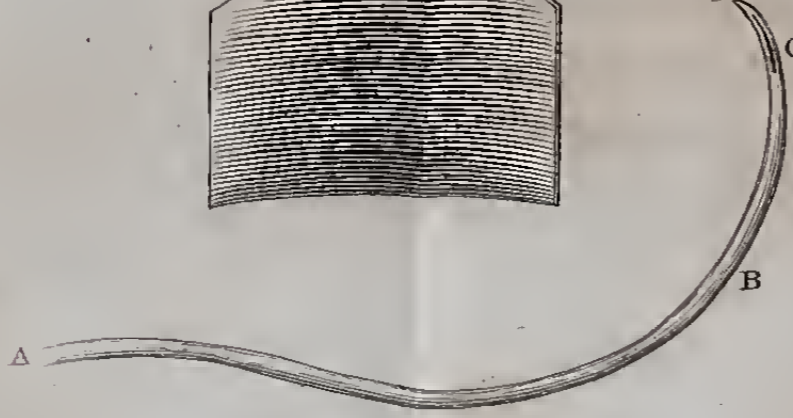


Fig. 8.



the abdomen. At length the gut makes a curve to the right side, and takes its course towards the podex.

In cod, haddocks, and such fish, the cæcula, which are esteemed analogous to the pancreas of other animals, surround the first gut, soon after it comes from the stomach; and then the intestine is fastened to the liver, where the biliary ducts open into it.

I designedly here leave the reader to follow out the same contrivances in this comparative anatomy as were mentioned in the human.

If then we consider what quantities of different substances enter the duodenum, some of which have rough hard parts, to rub violently on its sides; others have sharp saline particles, to prick and corrode; others are irritating rancid oils; others, in their digestion, generate great quantities of distending air; others, by their moisture and watery nature, are apt to relax the fibres; others, harden these fibres too much: If, I say, we consider this, we need not be surprised that this gut, the duodenum, should be more subject to maladies than any of the rest; especially as it has not such a firm covering of an external membrane, to assist it to resist the forces overstretching its fibres, as the other guts have. And if the gut itself suffers, how soon must it disturb many other functions of the animal œconomy, by the pressure it may make, when overstretchèd, upon so many large vessels, nerves, and other organs, to which it is inseparably contiguous; or by communicating its afflictions to those parts which sympathize with it by means of the common origin of their nerves; or by stopping the influx of these two absolutely necessary liquors, the bile and pancreatic juice?

Any tolerable account of diseases, from such causes as I have just now mentioned, would lead me far beyond the bounds of any essay you could admit of; and therefore I shall do no more than, with Santorini (*a*), recommend to practitioners to have such in their view, when they treat patients who labour under diseases of the epigastric or hypochondriac regions, that they may not confound those which have their seat in this gut with others which require very different treatment. This is the more necessary, because authors generally take little or no notice of the duodenum as the seat or cause of any particular disease.

(*a*) *Observ. Anatom. cap. 9. § 7.*

Miscellaneous Remarks on the INTESTINES.

THE preceding account of the duodenum has called to my remembrance some remarks that are commonly neglected, which I think may be made on the other chylopoietic viscera.

The intestines are generally described as being covered all over with an external membranous coat, which is said to be derived from the peritonæum. But it ought to be remarked, that a considerable part of the circumference of the human intestines is not covered with such a membrane: For the mesentery being formed by the peritonæum produced on each side, and including a considerable quantity of cellular substance, in which much fat is frequently contained, together with the numerous *glandulæ vagæ*, the large meseraic arteries and veins, and the nerves and lacteals, and the fatty cellular substance being thick till after the membrane of each side is continued some way upon the gut, all the space there between the membranes, which is always more than the distance between the insertion of the arteries that rise on each side of the gut, that is, a fourth at least of the circumference of the gut, must have no such firm membranous coat covering it; and therefore will more easily yield to any stretching force, which may be of use in allowing the guts to be more enlarged than otherwise they could be without overstretching their vessels.

It is in this space between the insertion of the blood-vessels that the longitudinal fibres of the guts can be seen most distinctly and easily; because the cellular substance is separated with little trouble, or collapses so much as not to hinder the view of the muscular fibres under it; whereas, in the part of the intestine opposite to the mesentery, the external membranous coat, whose fibres are very like to those carnosous ones, adheres

so firmly to them, that it cannot easily be distinguished or separated from them.

I need scarce observe, that the circular fibres of the guts are often so interlaced, that one can scarce trace the same muscular fibre round the whole gut.

It is now generally enough known, that all the substance between the interior side of the circular muscular fibres of the guts and the villous coat, which used to be divided into the vascular, nervous, and glandular coats, can, by blowing into a piece of gut whose interior side is turned out, be raised into a *tunica cellularis*, with numerous vessels running every where through it, without any fat in it; where, however, it would appear there is some secretion performed: for, by injecting water into the arteries, these cells are filled with it; and frequently, after making injections of grosser coloured liquors, I see a secretion performed, by the cells being here and there distended with the white injected substance, while the colouring powder does not pass with it, but is left behind. When this secreted liquor hardens, it forms a number of small round or oblong tubercles, which I have seen several willing to imagine were Peyer's glands filled with the injection; and this Ruysch (a) seemed likewise to think. I cannot yet bring myself to that opinion, because water diffuses itself so equally every where, and the injections which harden do frequently the same for a large space: at least, these make it evident, that if Peyer's glands are sometimes injected, there are also vessels which convey liquors into this internal cellular membrane; which may lead us into a more reasonable account of the very great discharges of mucus after an excoriation of the guts, and of the large extended hard tubercles that are frequently seen within their muscular coats, and of several other phenomena of diseases, than otherwise we could give.

In a piece of gut distended with air in the manner mentioned for demonstrating its internal cellular coat, we see the villous coat in its membranous form, and without the downy, papillous, and mamillary appearance which an inverted undistended intestine floating in water has.

Upon observing this villous membrane when it is stretched, remarking how thin and flexible the cuticula becomes upon the lips, with the continuation

(a) Epistol. 11. respons. & sparsum.

uation of the same membrane in the mouth, tongue, fauces, œsophagus, stomach, and intestinal canal; and upon comparing the properties which the most external common covering of the body has, with those of this villous membrane; we must be convinced they are very much of the same kind, if not the same continued substance. I do not know that all the properties of the cuticle have been considered by the authors who describe it, far less that a comparison has been made between it and any of the internal membranes, to show their analogous uses and advantages; therefore beg to be allowed to consider them a little in this way.

The cuticula is notourly pervious to liquors going out of the body, and to others coming into it; so is the villous coat of the intestines; and both of them have other passages through them, whereby they allow certain substances to penetrate to the nerves which they cover. Thus a numbness is brought on the skin by immersing any part of the body in several sorts of liquors, and pain is raised by substances which do not destroy the cuticle; thus sapid objects affect our tongue, and the different sensations arise which we frequently feel from the contents of the stomach and intestines.

The external epidermis, by being exposed to a variety of different forces acting upon it, is of very different thickness and firmness in several parts; but it is naturally formed so flexible, as to allow a sufficient impression of tangible objects on the nerves below it. The internal membrane of the guts is less exposed to a variety of such causes, and therefore is more uniform; but can be changed in the same manner by like causes: And hence frequently we find the interior surface of the stomach and guts of a callous hardness, and almost insensible; while for ordinary it is very sensible, and so flexible, that by being connected to such a loose cellular substance as already described, it hangs floating, and assumes any shape the contractile fibres of these cells give it, whether of large rugæ, called *valves*, or of smaller papillæ of different forms.

Thin watery saline liquors wash away the cuticula; thick mucaginous substances protect it against them and the bad effects of friction: therefore, wherever the cuticula is exposed to such injuries, its defence is likewise provided. Thus the eye-lids are defended against the tears and their mutual collision, by the sebaceous matter separated in their glands; the

the nipples, arm-pits, glands, urethra, perinæum, &c. are all protected in the same way. When their defence is wanting, we see the troublesome consequences, excoriation, pain, inflammation, &c. The internal membrane of the guts, being more exposed to the action of watery liquors, has a much more plentiful supply of the protecting liquors, and is always, in a sound state, lined over with mucus. Whenever therefore this mucus is carried off too quickly, as in diarrhœæ and dysenteries, or is not secreted in sufficient quantity, as in inflammations, or other obstructions of the intestinal vessels, we may easily judge what the consequences must be, and are led to supply by art what nature then is deprived of.

A certain moderate degree of friction makes little or no change upon the cuticula, nature easily supplying what is carried off. When it is greater, but gradual, and not so violent as to destroy its texture, or to separate it from the parts it is connected to, the effect is not a little surprising; the cuticula becomes thicker, stronger, and firmer, as we see every day in the soles of the feet, and in the hands of labouring people. When sudden violent friction is applied to the cuticula, either it is rubbed imperceptibly off, or it is separated from the skin. This daily experience also shews every one. The villous coat of the intestines is not exposed to such accidents as the external surface of the body, and is better defended by the slime from the bad effects of rubbing forces, while the abrasion or separation of this villous coat may well pass so unobserved, that one cannot give examples to prove circumstances in it analogous to those mentioned in the cuticula. The most surprising and least to be accounted for phænomenon, to wit, the thickening and hardening of the cuticula by friction, may, however, be also seen in the intestines, when any hard concremented substance is lodged a considerable time in any particular part of the guts; for then the internal surface of the intestines becomes there thick and hard.

The epidermis seems to serve for contracting the extremities of the cutaneous vessels, probably by forming their extremities; for whenever it is separated, these vessels throw out their liquors in much larger quantities than ordinary. I know the writers on this subject generally express themselves in such words as would persuade their readers they thought the cutaneous liquors were all thrown out of their vessels between the skin

and cuticula, and thence gradually escaped through the interstices of the cuticular scales. But if this were the case, there would perpetual blisters be raised in the depending parts of the body, if not all over the surface of it; and the liquor in blisters would escape through these interstices, which it does not. The same effusion of liquors is made into the intestines, upon the separation of the villous coat, in the end of consumptions, and in other diseases, where the tongue and throat shew the excoriated state of the alimentary canal.

When any part of the cuticula is separated from the skin, but still is continued with the adherent scarf-skin, it becomes thicker, especially if soaked with liquors. Thus the cuticle of blisters, and what separates from the edges of wounds and ulcers, is frequently very thick. The same thing happens in the alimentary tube, as is evident in aphthæ. And this observation only can account for the tubular thick substances frequently voided at the anus; which have been taken for pieces of the guts, because of their shape and firmness.

The epidermis is the most incorruptible and least subject to erosion of any part of the body. In abscesses, the pus has little other effect upon it than to separate it from the skin, and to tear it by its weight, but not to dissolve it. In gangrenes and sphaceli, it remains uncorrupted, after all that it covers is converted into a putrid mash; nay, it can allow the common *lapis septicus* to penetrate through it, and destroy the parts below, without suffering a solution of union in its own substance. Possibly this may be owing to its having no proper vessels or liquors. Whatever the reason of it is, it is certain the *tunica villosa* of the intestines enjoys the same properties; which are of the utmost advantage in both, considering how many substances of different natures are applied to them; some of which would certainly dissolve them, if they were capable of dissolution, and would expose us to the inconveniencies of pain, inflammation, effusion of liquors, &c.

Because these membranes of which I have treated, though indissoluble, are however separable from the parts they cover, the consequences of which separation are so bad, therefore they are the most easily and quickly regenerated of any organs in the body that are not of the same structure.

Whoever

Whoever calls to remembrance the analogous structure and uses of the most internal coat of all the hollow viscera, of the arteries, veins, &c. will see that I point at concluding all of them of the same nature with those I have now insisted on.

I never saw the *appendix vermiformis*, of any of the human foetuses which I have dissected, distended with meconium; and therefore cannot allow it to serve as a reservoir of the faeces during gestation, which several authors have imagined; but must join with those who assign it the use of furnishing mucus to lubricate the internal surface of the great sac of the colon, and to moisten the faeces in it, that they may more easily be pushed forward out of this part of the gut where there is the greatest difficulty in their progress, and where, by stagnating too long, they may bring on troublesome symptoms; witness the disease called *placenta intestinalis* in women with child, which I have seen more than once in hazard of being mistaken for some other disease that required a very opposite method of cure to what ought to have been used. The numerous mucous lacunæ observable in the human appendix, and the like structure in the cæca of brutes, are proof enough of the appendix serving the use mentioned, both in the human foetus and adults.

It will be said, that the appendix being so much proportionally larger in the foetus than in the adult, seems to indicate some other use it is also of to the foetus. But this proportional lesser size of this little gut in an adult will appear to depend upon the pressure it suffers, and being emptied so frequently of its contents; whereas in a foetus there is no respiration to squeeze it, and the meconium in the sac of the colon prevents its being emptied; so that the liquor separated by its glands being collected there, softens and relaxes its fibres, and distends it.

The neglect of considering what the different forces are, which act upon the several organs of the body, while in a foetus-state, and after birth, has, in my opinion, contributed to many disputes, which might easily have been put an end to by accounting for the phenomena, which were the subject of them, in this way of reasoning. I shall mention one re-

markable difference in the circulation of the blood, and some few consequences from it.

Though the heart and arteries of animals are able, by their action, to keep up a circulation in the larger vessels, yet, without assistance from some other powers, they cannot propel the liquors with velocity enough, and in sufficient quantity, through the small vessels. These assisting powers, after birth, are the alternate pressure of respiration and the actions of the muscles. We can observe at any time how much the circulation is quickened, by increasing these; and, on the contrary, how much all the secreting organs are infarcted and stretched by their almost stagnating fluids, whenever one of them, muscular motion to wit, is little exercised. Thus creatures turn fat when they have not exercise. Hence a recruit of all the necessary liquors in time of sleep. Hence the strong slow pulse of sleeping people. Hence the desire of continuing sleep, after a person has slept beyond his ordinary time. Hence the small waste of such creatures as continue long in a dormant condition without any supply of food. Hence a dry parched mouth in the morning, which is soon relieved by chewing. Hence a stiffness and laziness after abstaining from exercise too long. And a great many other phenomena, which will occur to any upon the least reflection.

Since then the heart and arteries of foetuses have little or no assistance from any alternate pressure in propelling their liquors, their secreting organs (where, of all the parts of the body, there is the greatest complication of vessels, divided into the smallest ramifications, with the least firmness and consequently resistance in their solids) must all be infarcted and distended, and therefore of a larger proportional size than in the adult, as we see their brains, liver, pancreas, kidneys, breasts, &c. are. So that the thymus and *glandule renales*, about which so much inquiry has been made, have so far nothing but what is common to other glandular parts.

It probably will be alleged, that the thymus and *glandule renales* lose more of their proportional size in the adult than the other organs named. Admitting this generally received fact, though, upon comparing them with the brain and some others, I doubt it ought not to be admitted as commonly stated; admitting, I say, this fact, it will not bring us under any necessity of being obliged to search out some particular use they serve

serve in the fœtus: for a view of their circumstances, as to situation and pressure, will account for all the differences observable in them. To understand this aright, it may not be amiss previously to consider one or two causes that may influence the growth of animal organs.

1. Then, it will not, I believe, be denied, that the growth of the parts of the body will be greatest where they are least confined and least exposed to pressing forces. The brain is at first inclosed in membranes, and is prodigiously large in proportion to the other members: as the bones of the skull become firm, its proportional size diminishes; and after they are fully joined, its proportional increase is very little. The testicles, on the contrary, are at first confined within the abdomen, and very small; afterwards, when they fall down into the loose bag the scrotum, they increase much faster.

2. The greater the force is with which our fluids are thrown into parts, or the greater the resistance is to the secreted or to the returning liquors, whether that resistance is owing to external pressure, smallness or unfavourable situation of the vessels, or to the viscosity of the fluid, *cæteris paribus*, the bulk of a part will be increased. A hand swells, upon pressing the veins of the arm. A tumour in the urethra, near the *caput galinaginis*, occasions a swelling of the testicles.

To apply these principles to the thymus and *glandulæ renales*, we need only call to our remembrance the situation of the one, in the double mediastinum, between the heart with its large vessels, and the sternum, with the lungs on each side. The other lies on the muscular appendix of the diaphragm, covered before by the chylopoietic organs. Neither of them have any excretory canal, except the lymphatic vessels be esteemed such. The veins of both have a short course, and that of the *glandulæ renales* is remarkably large.

The greater pressure which the thymus suffers after birth, from the increased action of the heart and of the lungs, is altogether evident. The immediate play of the diaphragm upon the other shows as evidently that there are scarce any glandular parts in the body, the change upon which as to pressure is greater after birth, compared to what it was before, than in these two; and therefore, by our first proposition, they should suffer in their growth upon this account. But to this is to be added the thinness of the fluids

fluids sent from them, and their short course in large vessels, which are almost peculiar to them; by which their vessels must be less distended, and consequently their increase less, by proposition 2.

Having endeavoured thus to account for the lesser proportional size of these organs in the adult, I would join in opinion with those gentlemen who assign them the office of lymphatic glands, both before and after birth, serving to dilute the chyle and thick blood, that is soon after to be returned to the heart.

HAVING thus exercised the common privilege miscellany writers assume to themselves, of digressing at pleasure, I choose to conclude with a subject something nearer to what I began with.

At the part of the mesocolon, which connects the sigmoid flexure of the colon near the left cavity of the ilia, where in most adult bodies there is an infundibuliform *cul de sac*, or thimble-like cavity, I could never observe in children more than one part of the mesocolon laid over the other, because of the great flexure of this gut at this place: and therefore I conclude the cavity to be accidentally formed by the growing together of the contiguous parts of the mesocolon; and that it is as needless to assign uses to it, as it would be to show how useful the concretion of the lungs and pleura is, which seldom misses to be observed greater or less in adult bodies.

A T Y M P A N Y *.

THE keeping of the register of patients, their diseases, &c. having fallen to my share in the management of the Infirmary or hospital for sick poor lately erected here, necessarily obliges me to peruse with care the journal of all the cases treated in the hospital, and recorded by the physicians and surgeons; among which there are several (notwithstanding the small number of sick which the fund of the Infirmary is yet able to maintain) that would not be unworthy of a place in your collection of medical observations. I affirm this with more assurance than can generally be done in behalf of hospital-cases, because the journal does not simply contain the name of the patient and disease, the receipts of medicines prescribed, and the time of the cure or death; but the preceding history of the patient and disease, with the particular complaints and symptoms, are recorded at their admission; and every day after, all the changes happening to the sick, with the evident effects of the medicines, are inserted; at the same time the physicians are not confined, in ordering the diet of their patients, to the common fare of the house, but are allowed by the managers to cause whatever food or drink they think most fit to be given, and such of the managers who are visitors in their turns take care that these orders are executed.

Having permission from the managers, I have made an extract from the journal of the following case, only changing the form of a diary, and abridging what I imagine your design does not require, but was necessary in such a record. If this specimen of hospital practice is acceptable to you, your yearly volume may always be supplied with some cases from the same collection.

MARGARET DOG, aged 22 years, was seized with a tertian ague in January

* Originally published in the Edin. Med. Essays, being Art. xxxii. of Vol. I.

nuary 1729; and being then servant in a public-house, had no care taken of her, but was allowed to follow every idle prescription that was offered by any of her acquaintances. Among a great variety of very uncommon medicines, she was persuaded to drink great quantities of brandy and powdered pepper in warm ale; which changed the intermitting fever into a most violent continued one, in which she was delirious several days: and as this went off, the ague returned; but with two, three, four, and sometimes five paroxysms in a day, which she often attempted to put away with all the vulgar specifics brought her. The disease, however, continued obstinately till August, when some doses of the bark were given her: after which she was attacked with sharp pains in her loins and belly, beginning commonly about the right *os ilium*, and rising upwards to cross over by the stomach to the left side, attended with gripes, borborygmi, and swelling of the whole belly; and for some weeks one of her legs trembled, became hot, and sweated at the same hour each day, while nothing like ague was felt through the rest of her body. The pains continuing, her belly became still more distended, and sometimes was stretched in a very short time to a great bigness; and then gradually subsided without evacuations of any kind, but always remained more swelled than ordinary. When winter came she mended, and was for some time almost free of her uneasy symptoms: but in the beginning of the spring, her pains and swelling returned; and after suffering them several weeks, she represented her case to the physician and surgeon then in attendance at the Infirmary, and was received as a patient there on the 24th March 1730.

Her symptoms at this time were, a more than ordinary constant swelling of her belly; but sometimes increasing so monstrously, that the skin seemed to be in great hazard of being torn; and her breathing was much straitened: The swelling gradually decreased without any evacuation; The returns and degree of this swelling were very uncertain; and when the belly was most detumefied, one could feel several unequal protuberant balls every where, but especially at the sides of the abdomen. Her stomach was good; she had no thirst; and her urine was in sufficient quantity in proportion to her drink. She was very costive; her menses
had

had returned at irregular periods for some preceding months. There was no œdematous swellings in her legs, nor complaints of any parts else.

At her first admission, she took several doses of purgatives ; which operated sufficiently, but brought little or no wind along with the fæces, and altered the state of her belly very little. On account of her being irregular in her menstrua, and a suspicion of pituita in the *primæ viæ*, she was next ordered some doses of calomel, which produced very little change ; and during two months thereafter, she was constantly taking large doses of the antihysterical medicines, either by themselves, or mixed with purgatives. The antihysterical plaster was kept always applied to her whole belly, and once or twice the semicupium was used, but without any appearance of the disease being cured, or certainty of the remissions she now and then had being owing to any particular medicine ; for though the swelling did not increase for two or three, nay, nine days following, more than once ; yet the hardness and tumours of her belly did not entirely remove, her costiveness always remained, she had no passage of wind any way, and the medicine that at one time seemed to relieve her was of no effect in the next return. From the time of her admission she had her menses only twice, viz. May 17th and June 21st.

During this period, there are some facts remarked in the journal which seem worth observing. 1. Several times, upon the swelling's falling, she complained of a headach, once upon the detumescence complained of pains through all her body, once of a giddiness, twice had a nausea and vomiting, and in the last threw up green bile ; and once her stomach swelled greatly, when the rest of the abdomen subsided. 2. During the flowing of the menses, she did not swell, but became very big upon their stopping. 3. Bleeding and emetics, which were made use of for some accidental urgent symptoms, had no very sensible effects in making the principal disease either better or worse. 4. She never had passage of wind any way, except a little belching some days before the first monthly evacuation.

Some time before the last eruption of the menses, the purgatives were given more sparingly, and the doses of the antihysterics of the strongest kind, such as *assaætida. ol. C. C.* &c. mixed with soap, were enlarged and given more frequently, and accompanied with the hotter antiscorbutics,

as they are commonly called, *e. g. Rad. raphan. rustic. recent. zinziber, &c.* infused in strong-ale with steel. The patient was ordered to use frequent and strong frictions to all the trunk of her body and extremities, and to exercise moderately. Immediately before the menstrea began to flow, clysters of the same kind of medicines were injected. The courses were in sufficient quantity; but as soon as they ceased, her belly increased in its circumference four inches and a half, but soon subsided; and then she complained of pains, which a gentle sweat carried off. Borborygmi were for the first time observed, on the same day, June 25th; and having taken some *tinctura sacra* at night, she passed some blood next day by stool. This again was the first appearance made by the hæmorrhoids, which she had been formerly subject to.

The two following days her saponaceous antihysterical and antiscorbutic medicines being still continued, she had such explosions of wind *ανω και κατω*, that none of the other patients would remain in the same room, nay scarce on the same floor with her. Her belly became less and softer than it had been from the first attack of the disease; her medicines, (with a dose of *syrup. de rhamno* at proper intervals, still were continued, only the proportion of steel was increased; her flatulent discharge went successfully on; and though for some time the swellings returned, she was strong enough to do the work of another servant of the Infirmary who had fallen sick; and having continued a considerable time in that station of servant to the hospital, she still used her medicines, till there had been no relapse for several months; since which she has been in very good health, notwithstanding her having gone from the Infirmary into service, where she wrought hard, fed indifferently, and commonly walked bare-footed.

HISTORIES of successful INDULGENCE of bad HABITS in PATIENTS.

THE old axiom in physic, That sudden great changes are dangerous, has been disputed by some moderns, who advise to give over immediately bad habits. I have seen numerous examples where it was necessary to have regard to them, and even to indulge patients in them, if we expect to make a cure. At present I shall mention only three.

I. A cook, in an eating-house, quarrelling with a servant-maid, she struck him with a large knife, and cut through a great share of the right pinna and septum of the nostrils, so that it hanged down towards his lip. He had bled a long time, and was very faint by loss of blood before his nose was stitched. His wife was allowed to give him some white-wine among the water-gruel he was ordered for drink, or to make some sack-whey for him. He, however, continued very low and faint, with sickness at his stomach, and headach, for three days; till his wife told me his ordinary way of living was to drink a good deal of ale, wine, and brandy, every day; and unless I would allow her to give him more and stronger liquor, she did not expect he would recover. I did not forbid her; which she interpreted an allowance, and gave a gill or four ounces of brandy with some of our ordinary ale. He was much better next day; and with this dose every day, recovered daily till he was quite well.

II. A man having broke the bones of his leg, after the fracture was reduced, I ordered him to have no drink given him, except water and milk, water-gruel, or such like. He did not sleep well in the night. Next morning I found his pulse very quick, but low, and with complaints of pain in his head, thirst, &c. Imagining some drunken companions I saw

come to visit him had given him some strong liquors, I ordered him to be more strictly watched by such who I was sure would obey me; and he was kept to the low diet rigorously. He did not, however, seem relieved at night; slept none all night; and next morning he was altogether delirious, got out of bed, kicked away the box in which his leg had been put, his tendons were starting, and he scarce knew any person; his pulse at the same time intermitting, and being very low. One then present, whom I knew to be a very complete drunkard of the low class, assured me I would kill him if I did not allow him ale and brandy; for that the patient had for several years outdone him in irregular living. I consented to allow a little. That night he was much better, and next morning was altogether free of fever, delirium, &c. when they acknowledged he had got a Scots quart of ale and a gill of brandy the preceding day, which had made him sleep well and sound. This daily allowance of ale and brandy, then, he had all the time of his cure; which went afterwards on without the least accident.

III. A distiller of spirit of wine at the West-port, sitting upon the edge of a tub into which the boiling remains of a stillful of wine had been put, slid back into it; by which his hips, thighs, scrotum, penis, and belly, were miserably burnt, the skin of these whole parts turning quickly black and hard. I endeavoured to promote a suppuration by scarification, suppurating ointments, and poultices; and as his pulse was quick, ordered him to be bled, and kept on a low diet. Next day he was much dispirited, with great anxiety, and a low quick pulse. The third day he was near as bad as what I mentioned the former patients to have been, when his wife insisted to be allowed to give him of the spirits he distilled; which he got, and soon became better, the suppuration coming on the teguments, which cured very well; his wife, near the end of the cure, acknowledging she had given a mutchkin or pound of spirits every day.

UNEXPECTED CURES.

IF practisers in phyfic and furgery have fometimes uneasy minds on account of patients the nature of whose difeafes they cannot judge with certainty, if they are difappointed now and then in the effects of medicines, and if they have the galling mortification of the fick dying unexpectedly ; they have, on the contrary, frequently the comfort and pleafure of being furprifed with the great relief which their patients, in very obfcure, or even in difeafes which they are ignorant of, receive from medicines, which either a very diftant analogy to fome known difeafe, or the neceffity of mitigating fome urgent fymptom, have made them prefcribe ; nay, the event fometimes is prosperous when the medicines are differently applied, or have other effects than the prefcriber intended. Though people fhould be very cautious in laying down any general rule in practice, and ought not to found it on one or two obfervations ; yet I muft think fuch unexpected cures as I have hinted at, deferve to ftand on record, that, if the medicines employed are not of a very offensive nature, they may again be tried in fimilar cafes ; fo that fick people may have fome more chance for their recovery than the common methods give. The following may ferve as a fpecimen of fuch cafes, of which many more might be given ; and it is not doubted but that every practitioner can add to the number.

I. A middle-aged healthy man having bruifed the extremity of the penis, the part of the prepuce where the frenum of the glans is was raifed into a large cryftalline tumour. Topical aromatic fomentations and fuffumigia being applied to it, and cathartics being given, without its yielding, a fmall feton was put through it, with the view of allowing fome of the watery liquor to ooze out, and of bringing on a gentle fuppuration. Inftead of this, it occafioned fharp pain, and a violent inflammation ;
which

which made it necessary to take out the cord, and to apply an emollient poultice of bread and milk. Next day after this, the tumour was greatly diminished; and the second day it disappeared, without a return.

II. A young man had a great many pale-red excrescences, of a very unequal surface, with small necks, on the interior side of the prepuce; and when the prepuce was turned back, coxcomb excrescences were likewise seen on as much of the glans as he could uncover. The account which he gave of his disease to Dr James Dundas and me, was, That, having a small wart on the edge of the prepuce, he cut it away with a razor; soon after which these excrescences began to appear. Mercurial ointments, astringents, escharotics, and several other medicines, had been tried in vain, and he had undergone six weeks salivation without any benefit; though he averred solemnly, that he was sure they were not owing to any venereal cause.

I tied a silk thread very tight round the neck of one of them: he complained of sharp pain while the noose was drawing, which soon ceased; and in two days the tumour dropt off, leaving the surface of the part it rose from smooth and sound. I desired a young surgeon, who had seen me make this ligature, to take the other excrescences away in the same way. When this young gentleman attempted next day to put a ligature on one of these excrescences, he was timorous, and the patient was not obsequious; so that the ligature was not made tight enough to mortify the tumour. The patient felt very sharp pain all that day; and by next morning a very considerable inflammation was raised; for which he was blooded plentifully, and emollient fomentations and poultices were applied to the part. After two days the inflammation abated, and the excrescences were all considerably diminished; and, as the inflammation went off, they shrivelled: So that, after eight days, during which the emollients were continued, it could not be known where the excrescences had been.

Whether was it the inflammation, or the emollient applications, which made the cure in these two cases? In my opinion, it was the inflammation; and I am confirmed in it by the success which I have seen of stimulating medicines in slow cold swellings.

III. A man who had been subject to the gout, was by accident burnt
superficially

superficially in the face and hands. After the burnings were all skinned, a spongy excrescence, the base of which was equal to a sixpence, rose out from the point of his nose; and such another, as broad as a shilling at its base, rose out from the right cheek. They were both of a pale-red colour, and of a granulated surface, throwing out from imperceptible pores a thin liquor, which fell down in drops so fast, that a considerable quantity of it could have been collected in a short time. After different plasters, ointments, astringents, &c. had been tried to no purpose, I covered the excrescences with the fine cotton of old linen, scraped with a knife, and wet with alcohol. I desired the cotton might not be taken off, but that it should be wet three or four times a-day with the spirit. After this application, the oozing of liquor decreased, and in two days ceased altogether. The cotton adhering to the excrescences, they shrivelled, and at last became smooth and plain with the other parts of the skin, leaving only a little redness for some time.

IV. A young man of a weak constitution and thin habit, having fallen from a height, was bruised in a great many parts of his body, and particularly in the hypogastric region. He complained soon after of a sharp pain in the penis and region of the bladder. Those he advised with, suspecting these pains might be caused by some remains of a virulent gonorrhœa which he had two years before, injected some acrid medicines into the urethra; which increased the pain, and occasioned a considerable inflammation in the penis. When the inflammation was removed, he had great difficulty in making water, with sharp pain along the whole urethra when it did pass. He then took several doses of sweet mercury, drank the decoction of the woods, and continued some time the use of gummous pills with some grains of mercury in them. The symptoms becoming, however, worse, I was consulted about him four months after his fall.

He complained of a torturing pain at the root of the penis, and in the glans, when he attempted to make urine, which let fall a white furfureous thick sediment in great quantity when it cooled. I advised mild-mucaginous medicines, and an emollient healing injection, with fomentations to the pained part. These made him a little easier, but did not remove his disease; and he was seized with feverish paroxysms, which
had

had the full type of ague, but without regular returns. These wasted his strength and flesh so fast, that there was a necessity to stop them; with a view to which, and to his original disease, the following electuary was ordered: *R. Pulv. patrum, drach. ii. Gum. Arabic. drach. i. sem. Sal. nitr. drach. i. Pulv. milleped. unc. sem. Sal Jov. Londin. scrup. i. Syrup. diacod. q. s.* Of this he took the bulk of a nutmeg twice a-day. The aguish paroxysms went off gradually, and the other symptoms became milder, till he was free of all his complaints in some weeks; and he has continued free of them ever since.

V. Alexander Strachan, gardener to Mr Erskine of Grange, had a colic, which continued a day in the beginning of February 1734; after which a painful tumour was observed towards the left side of the epigastric region, which soon increased, and extended itself over that whole region. He took some purgative medicine, after which he had a constant diarrhœa.

When he was received into the Infirmary 6th March 1734, a suppuration seemed to be so far advanced in the tumour, that the surgeons felt a fluctuation of liquor lodged deep, and the left part of the tumour pointed outwards. He complained of a sharp pain in the left shoulder; and the skin of his face had that leadish colour which is almost peculiar to people whose livers are suppurated. His pulse was quick and low. He had no desire for food; and, upon taking it, the pain of the epigastrium was much increased. He had perpetual thirst, slept ill in the night, and sweated much in the morning, with a diarrhœa still upon him.

To promote the suppuration, a poultice of oat-meal boiled in water, with some basilicon and bruised raw onions, was applied to the epigastrium, and renewed thrice a-day. Some drops of laudanum were given at night, to stop the diarrhœa and to procure rest. Mild food and drink were ordered.

The suppuration seemed to advance outwards for four days; the dose of the laudanum being gradually increased to check the diarrhœa, which frequently returned, but without any pus in his stools.

On the fifth day, the tumour was evidently diminished, softer, and less painful; but he was faint, for which he had sack-whey allowed him to drink sometimes.

His

His poultice and laudanum were continued, the tumour gradually diminished, and his hectic symptoms went off, without any observable evacuation of pus ; so that, April 26. he was dismissed heal and strong.

VI. A child eight months old was suddenly seized with violent epileptic fits ; after having had several, was let five ounces of blood at the jugular vein ; and soon after, being put into a cradle, covered over with a cloth, lost a considerably larger quantity of blood, the cloaths about her being all wet, and the child in a faint and very pale. She continued weak and pale several days ; but never has had any return of the epilepsy, though she has since that time undergone all the common eruptive diseases.

VII. A woman in the decline of life, and of a broken constitution, had been several weeks in a rheumatic fever ; out of which she narrowly escaped, after repeated blood-lettings and other medicines. Two years after, she was seized with the same symptoms which had appeared in the beginning of the former fever, to wit, anxiety, thirst, vomiting, pains of the whole body, and particularly of the head, with a high quick pulse. She was taken ill in the morning, and in the evening fourteen ounces of blood were let at the vein of the arm ; which gave her little or no relief. In the night-time, the blood burst out again at the orifice of the opened vein, and, besides wetting all the bed-cloaths, was lying in clots at her side before it was taken notice of. A clean bandage being then applied, she fell asleep, and waked next morning free of all complaints.

VIII. In January 1739, a sharp pain struck into my right eye, then gradually seized all that side of the face, contracted the eye-lids, made the tears rush out, and affected all the teeth of the upper jaw. It began between ten and eleven o'clock in the morning, increased till about four in the afternoon, decreased till six, and then went off, without a critical evacuation of any kind, so far as I could observe. In the paroxysm, my pulse had no disorder in it ; and in the intervals, I was as well as ever. The inconveniency of confinement at that season of the year, and the hope of each fit being the last, made me suffer these periodical pains ten days, without trying to remove them by any medicine.

The pain increasing daily, and making me at last unable to do my work, I let ten ounces of blood, and took a vomit a little time before I

expected the paroxysm would begin. The vomit operated severely, but did not prevent the return of the pain ; which continued till the medicine began to go downwards, when I was relieved : And having purged twenty times before night, I had no more return of the disease.

Since that time, I have cured several of this disease, by giving them a vomit, and a brisk purgative, soon after this operation was over, if there was no appearance of the emetic's acting also as a purgative.

IX. A man brought a quartan ague and the French pox from England. The ague was in vain attempted to be cured by the common remedies ; and, in the mean time, the pox advanced, the nocturnal pains increased, and the foul ulcers in his throat spread. His physician (from whom I have this account) gave him five grains of sweet mercury at night, immediately after the fit of the ague was over ; repeated the dose next morning and evening, and the morning of the following day. After taking these four doses of mercury, he had a fit of the ague, which was more severe than any he had formerly undergone ; the fever being higher, with delirium, but without any other bad symptom. After the fit was over, the mercury was repeated as formerly till the salivation rose. He never had more appearance of the ague ; and the venereal symptoms disappeared by the use of the mercury.

I was willing to borrow this case, because, so far as it relates to the ague, it was an unexpected uncommon cure of a disease little known in this country ; the quartan agues not having been seen here, except produced in other countries, until within the last ten years ; in which they have been observed in some parts of the country, but have not been general.

Of the EFFECTS of the PERUVIAN BARK in GANGRENES, ULCERS, and SMALL-POX *.

THAT no man ought to be tempted, by any view of private reputation or gain, to conceal what can be for the general benefit of mankind, is a principle which I know the gentlemen of your society maintain, and their practice is conformable to it. Letters which I have received from several gentlemen at a distance from this, informing me that I have got an infallible secret for the small-pox, and begging I would send them some of the medicine, whatever price it is, make me afraid of having a character you justly think so condemnable. Relating what I know on the subject in public lectures and private conversation, is not sufficient, it seems, to keep away this imputation from me; I am therefore obliged to apply to you to publish the observations I have made on the use of the Peruvian bark in the small-pox, which is the only medicine I have employed in this disease that is not commonly prescribed.

After the good effects of the bark in gangrenes were known, I had occasion to use it several times in that disease with success; and sometimes, by necessity or choice, gave it in an injection by the anus, rather than by the mouth, as I had likewise formerly done in agues. The quantities given in clysters were larger, but the effects were the same. One cure of a gangrene made, I think, by the bark in clysters, seems to me so remarkable, that I must give you the history of it.

A young gentleman, very healthy in appearance, had strained his left hand, but had no uneasiness in it for ten or twelve days; at the end of which he was suddenly seized with a very sharp pain near the *os pisiforme* of the wrist, and soon after the teguments on the anterior part of the me-

* Edin. Med. Essays, Vol. V. Art. x.

tacarpal bone of the little finger swelled: He neglected to ask advice for two days; then some student who saw it, observing a mortification begun, scarified the skin, fomented the part, and applied some digesting ointment with oil of turpentine; which dressings were continued also the third day.

On the fourth day, when I saw him first, the teguments covering the short muscles of the little finger were all mortified; his pulse was so low that with difficulty I could feel it, and it was so quick that I could not number the beats of it. He had a general tremor over all his body, and the *subfultus tendinum* was very frequent; he had a constant anxiety, restlessness, and delirium; his tongue was parched and dry; and whatever food or drink he swallowed, was vomited almost before it got down to his stomach. The gangrened parts were again scarified and fomented, their edges were dressed with warm *ung. basilicon*, to which a small proportion of oil of turpentine was added, and a poultice of *theriaca Andromach.* was put over all. Soon after, his great guts were emptied by a laxative clyster; and as soon as the operation of this was done, five ounces of warm milk and a drachm of the powder of Peruvian bark were injected, which he retained. Four hours after, the milk and bark were repeated, and two such more injections were given in the night-time.

Next morning he had no raving, tremor, subfultus, or vomiting, and his pulse was stronger and slower. The hand was dressed as the preceding day, and the injection with the bark was repeated. In the afternoon it was changed, upon the patient's desire, for a bolus of half a drachm of the bark, which was repeated every four or five hours. The fever ceased; the gangrened parts began to separate next day; and the bark being continued several days, the cure went on without any further accident, except that he was put to a good deal of pain one day by an application of ill-prepared *aqua phagedænica*. This I mention, to have an opportunity of warning the younger surgeons not to make use of that medicine, unless when the lime-water is strong enough to make the solution of the corrosive sublimate mercury to turn turbid, and to precipitate in form of a very fine red powder; for, if the lime-water be effete, and remain clear after the sublimate is mixed with it, instead of a very mild medicine, they are to expect all the effects of unaltered corrosive mercury.

In all the gangrenes where the bark was given with success, I observed that it brought on a mild suppuration; which I saw become worse when the use of the bark was interrupted, and then turned of a good kind when the bark was again given. This made me join in opinion with others, that it would also be of good service in several sores where the suppuration was faulty: Experience proved we judged right; so that the bark became a common and a beneficial medicine in this town for all sores.

This effect of the bark, in procuring a kindly mild suppuration, led me to imagine it might be serviceable in the small-pox of a bad kind, where either a right suppuration did not come into the pustules, or petechiæ shewed a disposition to a gangrene; and I had the pleasure to see the effects I expected from it in several variolous patients to whom I gave the bark: The empty vesicles filled with matter, watery sanies changed into thick white pus; petechiæ became gradually more pale-coloured, and at last disappeared; and the blackening of the pox began sooner than was expected. I no sooner had the good effects of the bark in the small-pox ascertained by trials, than I spoke of it to other gentlemen in practice here; some of whom had reasoned in the same way I had done, and had been giving it to their patients with success; since which I have had thanks from some of my friends in the country to whom I recommended this practice.

I gave at first the decoction, and then the extract, of the bark: afterwards I forsook these weaker preparations for the fine powder, which was mixed with some mild rich syrup, and an aromatic distilled water; both which may be varied as the patient prefers one sort of taste to another. In this form, from ten to forty grains were ordered to be swallowed every four or five hours.

But as several children could not be prevailed on to take it by the mouth in any form I could contrive, and, through fear of having this medicine given, would taste neither food nor drink, there was a necessity of using the other form of clysters. Previous to giving the bark this way, the great guts were unloaded by a laxative injection; and then from half a drachm to two drachms of the jesuits powder was injected, with a small quantity of warm milk; to which some diascordium, or syrup of poppies,

was

was added, if the clysters were retained too short time. These injections were repeated morning and evening, or oftener.

I have hitherto only given the bark in the small-pox after the eruption, and continued it till the blackening was completed; but am persuaded, from the effects I saw of it in mitigating the secondary fever, that, if it is given during the eruptive fever, it might be of use in determining the small-pox to be of a favourable kind.

I hope what I have said will not be understood as if I recommended the bark as an infallible universal remedy in those diseases, and the only one that needs to be employed in them. So far from meaning any such thing, I have seen it fail more than once in both gangrenes and small-pox; and, in general, I know no medicine which is not capable of doing hurt to patients under some particular circumstances of the very disease for which it is given with the most success. Thus in the small-pox, when the lungs are violently infarcted, I would not consent to give the bark: I have seen patients in this condition almost suffocated after a small dose of it.—They would also, in my opinion, do very ill who would trust entirely to the bark, neglecting the other medicines which have been used to advantage in the different circumstances of this disease. The bark would not surely moderate a very high, full, hard pulse, with high breathing and inflamed brain, in either eruptive or secondary fever of the small-pox, as blood-letting would do: The bark could not clear the stomach and bronchiæ of viscid phlegm, as an emetic would: It would not, single, calm the general spasm, or relax the skin to make way for the eruption, as when assisted by a tepid bath: Nor would it raise a sinking pulse, or discharge a load of viscid humours, as the stimulus of a blister, and the suppuration after it, will frequently do. In short, I pretend to recommend it no further than as an excellent assistant to nature, in what the ancients called the concoction and maturation of the morbid matter; the effects of which appear in moderating the fever, and bringing a kindly mild suppuration, which are indeed grand articles in the cure of gangrenes, ulcers, and small-pox.

Anomalous Appearances of an AGUE*.

BY your allowing the case I formerly extracted from the records of the Infirmary here a place in your first volume of Medical Tracts †, I have reason to think other examples of hospital-practice, if tolerably well chosen, will not be disagreeable to you. I have picked out the following history, because of its being so near of kin to the one I sent you last year; both being the effects of an ill-managed ague, with some anomalous appearances common to them; but at last the symptoms come out very different; and the manner of their being carried off is singular in each, and uncommon in both.

ISABEL DURIE, of a low labouring station of life, was always irregular in her menstrual evacuations, being sometimes obstructed for a whole year together; and was frequently attacked with a vomiting of blood, for which she had used a great variety of medicines; but never was relieved till 1727, which was the 37th year of her age, when she took some purgatives, and had the bloody vomitings only twice ever since. In November 1728, after a regular course of the menses, she was seized with a quotidian ague, which continued all the winter, and wasted her flesh and strength greatly. Towards the spring the paroxysms became very irregular, both in their time and type; she had a constant nausea and want of appetite, with pains through all her body. From the first attack of the ague her menstrua ceased to flow; nor had she any appearance of them ever since that time.

In the summer of 1729, she used many common cures for her ague, such as vinegar, the roots of the *bellis minor*, *cortex Peruvian*. &c. with which she put it off for some little time, but always soon had irregular returns.

In

* Originally inserted in the Edin. Med. Essays, being Art. xix. of Vol. II.

† Ibid. Vol. I. Art. xxxi. or N^o 41. of the present Collection.

In March 1730, instead of suffering the common cold and hot fits, she was seized with a violent trembling, or rather shaking, of her arms, or of her head, or of her legs, or of all together; which observed no certain period of time, either in their continuing or intermission, but attacked her three or four times one day, then took the form of quotidian, and afterwards intermitted several days, and soon again appeared in some of its former shapes.

On account of these anomalous shakings and flying pains in her head, neck, breast, and belly, she was admitted into the Infirmary on the 15th of August 1730. Her pulse was then little altered from the ordinary healthy state, even in the time of the tremblings; which, however, were so violent, that a strong man could not hold one of her hands from shaking. Her appetite and digestion seemed to be good; her belly did its office sufficiently: her urine was in large enough quantity, and of a good colour, without any lateritious sediment. There were no preternatural swellings to be observed any where in the patient's body.

When she was first taken in, her disease seemed to yield considerably, and at last to be almost cured, by the use of mustard-vomits (a) repeated every three or four days, and by taking two drachms of *crude sal ammoniac* every morning. But in the beginning of September, the pain of her stomach returned, and the irregular shakings soon succeeded, and did not yield to the former medicines. She was therefore ordered frequent and large doses of the stinking gums, galbanum and asafœtida, with *sal. C. C.* and an aloetic purgative was now and then given her. These at first relieved her; but soon lost their effect, all the symptoms returning with their former violence. Her vomits and salt were again tried; which failing, she took the hotter alexipharmics, and these were succeeded by the strengthening stomachics: but though she acknowledged herself relieved always for a day or two, on the change of the medicines, she was soon as bad as ever.

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(a) This being a little out of the common road of practice, would be the better of being a little explained. The powder of mustard-seed is made into the consistence of a loch, with warm water, in which a little sea-salt has been dissolved. Of this a common spoonful, sometimes two, diluted in tepid water, are given with an empty stomach; and operates as well as an emetic, and proves an excellent remedy in most of the nervous disorders. I have seen its good effects in the Infirmary, and among my private patients since I was taught it there.

The physicians and surgeons being so often disappointed, and her case appearing to prove a very tedious, if not incurable, disease, while recommendations were presented for several other diseased people who needed immediate assistance, she was dismissed on the 8th October.

She lived at Leith after this, where she had no assistance, but sometimes came to town here to ask my advice; by which I became acquainted with the sequel of her history. Her tremblings and pains continued in the same way, notwithstanding some nervous medicines I gave her, till the middle of December, when her right arm swelled considerably at the joint of the elbow, with very racking pain, and her tremblings left her. By my advice, emollient poultices of bread and milk, with some althea ointment, were applied: they relieved her somewhat of the pain; but the swelling of the joint increased, and a slow suppuration at last came on in April following. When the abscess was opened a little below the olecranon, a considerable quantity of watery pus was evacuated, and she had some dressings delivered her; but having no skilful hand to apply them, and not being in condition to come frequently to town, her fore degenerated into two fistulous ulcers, which continue still to discharge a small quantity of a thin ichor. Her fore-arm is bended and rigid, with little or no motion in the elbow: but she has been all this time free from the bloody vomitings, flying pains, tremblings, and all other complaints, except the trouble of her arm.

This woman's disease went off in but a very indifferent manner, she having lost almost the whole use of one arm: yet it is the most favourable case of that kind that I have either seen or heard of among my acquaintances; for no other, of several whom I could name, under those irregular shakings, after an ill-managed ague, have at all recovered. I saw one who has suffered a tedious continued fever, with the advantage of only a few weeks remission from shaking.

REMARKS ON CHALYBEATE WATERS *.

THE ingenious account of several steel-waters in some of our northern counties, given by my worthy friend Dr Thomson physician at Montrose, [Med. Essays, Vol. II. Art. vi.], raised a desire in me to be informed of the most remarkable mineral waters of that kind which are to be met with so frequently all through Scotland; and as my view was only to know so much of them as was necessary in practice, I proposed to discover, by my friends and correspondents, what their real or comparative strength was, and how well they would carry and preserve without losing their virtues, whereby physicians might judge which of them was most proper in the various diseases and circumstances of patients, and which must be drunk at the fountain, or would serve as well when kept.

It was necessary, in such an inquiry, that there should be some general method by which all the trials should be made, otherwise there would be an insuperable difficulty in making the comparison of them. The writers on this subject have contented themselves with telling us, that such waters strike a red, purple, violet, or black colour, when galls or such other astringents are mixed with them; and that this change of colour is a sure mark of a chalybeate water; and some have said, that the deepest colour shews the greater proportion of steel. To satisfy myself of the truth of this, I dissolved artificial *sal martis* in a small quantity of fountain water; and then dropping more or fewer guts of this solution into a given quantity of common water, I found that, by the mixture of the tincture of galls, I could form all the different colours mentioned, the larger quantity of the solution always requiring the greater number of drops of the tincture to bring it to all the colour it would take, and that
being

* Originally published in Edin. Med. Essays, being Art. vii. of Vol. III.

being as constantly deeper than the others where fewer drops of each had been employed. If words could express the numerous degrees of colours between the pale-red and the black, the lightest and deepest of these mentioned, the simple experiment of bringing steel-waters up to the deepest colour they could strike with galls might be sufficient to determine the different proportions of steel in each; but as the variety of colours cannot be expressed in words, and I wished to come to the knowledge of nearly the real quantity of steel contained in any given quantity of each water, there was a necessity of having some general standard to which all might be brought. To obtain this, I observed the quantity of steel employed in preparing *sal martis*; saw how much salt was got, what the residuum of earthy parts was; made a small allowance for some evaporating during the effervescence of the *limatura martis* with the oil of vitriol; and concluded, that the proportion of steel in the artificial salt or vitriol of iron, was very little more than a third part. Next, I dissolved a certain quantity of this *sal martis* in fountain-water, weighed the powder that precipitated from it, weighed the whole solution; and then, putting some of it into a small glass, I dropped it *guttatim* into another glass, counterpoised exactly in a scale, till I saw how many drops of this liquor weighed two drachms; after which, by common arithmetic, it is easy to know how much salt, and consequently very near how much steel, it contained in any given number of such gutts. To save my friends the trouble of making such solution, I prepared 20 ounces, which contained an ounce of the *vitriolum martis*, except a scruple which was precipitated; and 142 gutts of this solution weighed two drachms: therefore every such gutt contained $\frac{1}{23}$ of a grain of salt, or $\frac{1}{89}$ of a grain of steel. The difference of the bulk of the drops let fall from different glasses should not, at this rate, make a very considerable error; but to prevent this as much as I could, I chose all the glasses as near to the shape, size, and thickness of the lips of the one I first used as I could get them.

To make a comparison, then, of any chalybeate water with this solution; into a determined quantity of such water, pour drop after drop of a strong clear tincture of galls, allowing a sufficient time between each drop for its having its full effect, till it is observed that the addition of more tincture makes no change on the colour of the water; and to make:

ture of the number of the gutts of the tincture that are requisite, let the experiment be repeated several times. Then having the same quantity of common water as was employed of the mineral water, in a glass of the same dimensions, thickness, and transparency, with that made use of in the preceding trials, pour into it the number of drops, discovered by them, of the same tincture of galls, and mix them well; after which, in the same cautious manner, drop in the solution *guttatim* till their colour is the same with that of the mineral water. When once the quantity of solution, equal to the contents of the spaw, is known, pour a due proportion of it into common water, and let several people examine whether the taste of it is not the same with what the mineral water has. I have thus made fountain-water so like to several chalybeate waters, that none could distinguish them.

I prefer tincture of galls to their substance for making the foregoing experiments, because it produces its effect much sooner and more equally than the powder, and a less proportion of the virtue of the galls can be added at once; which, from an observation communicated to me by Dr John Taylor physician here, and verified by me afterwards in several steel-waters, and in common water impregnated with *sal martis*, would seem very necessary to be regarded: for if too large a proportion of galls is at once poured into such waters, for example, if 60 or 100 drops of a tincture of gall is thrown into a water that requires only eight or nine to bring it to its deepest colour, it will be so far from making it strike the colour stronger, or sooner, that, for several hours after, no change will be observed on the water; and at last it gradually becomes of a deep sea-green colour, instead of the purple or violet it would otherwise have turned into. It is not impossible that good chalybeate waters have been sometimes condemned as containing no such mineral, or of being impregnated with copper, by a mixture of too much galls at random.

Recent tincture of galls is certainly preferable to that which is long kept; but I can assert, that after I had kept such tincture till it was covered with a thick moss, or was mouldy, as we call it, a-top, and had a viscous thick sediment, it still produced the common effects on steel-waters.

I would propose, that the comparison above described should be made
with

with fresh water at the steel springs in different seasons; and should be repeated once a-week with water that is right put up in bottles, well corked and sealed, in these different seasons, till it becomes vapid by keeping; by which the proper seasons for bottling the mineral waters, and the time each will preserve, can be much more exactly known than it is possible to determine by the smell and taste of them.

It will be also requisite to observe what time it is before the galls strike the colour fully after they are put in, and to remark how long this colour remains in an open glass; for it appears reasonable enough to think, with the French academist Mr Geoffroy (*a*), that more time will be necessary to strike the colour fully, but that it will remain longer in such mineral waters where the steel is most intimately dissolved and blended with the other principles.

To make the account of the spaws complete, their other contents ought to be sought after, by mixing different substances with them, remarking the changes they undergo in smell, colour, &c. by keeping, and by extracting their salts and earths after evaporation.

By these means it is, that I was in hopes to have furnished you with a pretty complete list of the most remarkable spaws in this country, with the comparative strength of each, and the time they kept; but being disappointed of several I expected, while information of others I had not heard of are often brought me, I shall reserve what I have received, till I can present you a more full account, which your publication of this invitation will probably soon enlarge, by acquainting the gentlemen who have the opportunity of examining such waters, of the common method they should all take in their inquiries, and to whom they may address their discoveries. In the mean time, allow me here to annex some experiments, which thinking on this subject led me to make.

I had observed, as above, a strong resemblance between our steel-waters, and common water in which a small quantity of *sal martis* had been dissolved. But the natural spaw waters, when exposed to the open air, very soon lost their chalybeate taste, and would not strike a purple colour with galls: when exposed to heat, their virtues were much sooner lost; and in the closest vessels they, in no long time, became vapid: whereas

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(a) Memoires de l'Acad. de Sciences, 1724.

sal martis bears heat, and being exposed to the air, without perceptibly losing any thing. I suspected this difference might in part depend upon the smaller proportion of the vitriolic principles in the chalybeate waters, and some change they might thereby undergo in the water; and therefore, having added to some bottles of water as much *sal martis* as had been found to make it of the same taste and to strike the same colour with chalybeate waters, I corked some carefully up, others I put bad corks into, and a third sort I left open. The water in these two last lost its taste and virtues in about a fortnight, with little other change than becoming a little muddy, and having a saffron-coloured powder at bottom. The second kind kept some time longer, but had a little of a stinking smell before it became vapid. The water that was carefully corked and refined kept well; but acquired a pretty strong smell of rotten eggs, exactly like to what several spaws had when kept; and when the bottle was left open, the stinking smell went soon off, and soon after the chalybeate virtues were not to be observed, and the bottom of the bottle was covered with the saffron-coloured powder, which is generally to be seen also in bottles where natural chalybeate waters have been kept any time. So far, therefore, the difference between the natural and artificial steel-waters seemed only to be in the greater volatility of the natural ones.

Several of our own chalybeate waters, and the two foreign ones of greatest reputation, Spaw and Piermont, seemed to me an exception to the resemblance I had found between the diluted solution of *sal martis* and the natural steel-waters; for the colour they strike with galls is very faint, while their taste and other effects are remarkably strong. This put me on trying to find some artificial way of imitating them: for this end, I mixed filings of iron, oil of vitriol, and water, in a florence bottle, which I laid on its side; and immediately fitted another to it, in which I had put some fountain-water. The fumes that rose upon the effervescence of the oil of vitriol with the steel, came over into the other glass. After the violent effervescence was over, I took away the glass with the water, which was quite limpid, but had a strong emyreumatic smell; its taste was pungent at first upon the tongue, and then the acidulous taste prevailed. When tincture of galls was mixed with it, it became of a red-purple but faint colour, which held a great many days without any observable

fervable precipitation. Next morning, the empyreuma of the remaining water was gone, and it had a very agreeable brisk spaw taste: In less than a day after, this also went off; a small quantity of the saffron-powder was fallen to the bottom of the glass, and the galls had no effect on the water.

On a suspicion that this artificial water would give evident signs of acidity, whereas the solution of *sal martis*, and some of the spaws that strike a black colour, rather appear alkaline, by changing syrup of violets and clove-julyflowers into a green colour, I mixed it with these syrups, without changing the one into red, or heightening the colour of the other. It is true, it did not make them green, neither do the more spirituous spaws.

The success of this experiment, which was beyond my expectation, led me to try if I could not discover what it was that evaporated, and what was precipitated in these waters. I suspected the menstruum to fly off, and the steel to be left behind. To know then if this saffron-coloured residuum was steel, I poured oil of vitriol on it, which made no remarkable effervescence: I then added water, and let them stand two days, when some of the powder seemed to be dissolved. Upon mixing tincture of galls with it, the colour did not change; but upon further addition of spirit of hartshorn, a great effervescence followed, and a sudden coagulum of a deep red purple substance was made. This change of colour I at first imagined to depend on the residuum; but upon mixing the other ingredients without any residuum, the same coagulum was formed; and therefore, if the powder precipitated from the mineral water is the particles that composed iron, they are greatly changed. The resemblance of the rust of iron to this powder, made me try how these experiments would hold with it; and they came out in the very same manner: nor would rust, or the powder, when suspended in water, strike any colour with galls, though the *crocus martis* of the shops did.

What flies off in the evaporation is evidently the menstruum, in which the irony particles were dissolved, which carries away some of the principles of the iron with it. From seeing the effects of acids on iron, observing the effects of that almost universal menstruum of the air upon this metal, and finding vitriol of iron naturally formed, we have reason to judge that the menstruum of the irony particles in chalybeate waters is also

also an acid: And considering how much sulphur enters into the composition of iron, what a strong stinking smell (which can only depend on sulphur) mineral waters have before they turn yapid, and how much the sulphur of iron is destroyed before the iron turns into rust; which again resembles the powder precipitated in these waters; all this would persuade us, that the menstruum carries the sulphur along with it, and leaves only the earthy parts, with a small proportion of sulphur.

May not steel-waters be impregnated with common gross vitriol, or with the more subtil fumes of iron dissolved in the natural menstruum, or with both in different proportions?

Will not the less volatility of some chalybeate waters, and the quicker precipitation of their irony particles after the mixture of galls, shew the sulphur not to be so much freed from the earthy particles, as in others that precipitate more slowly and are more volatile?

Will not the common observation, of air generated in all effervescencies, fermentations, putrefactions, and wherever a considerable change is produced in the composition of bodies, account for the quantity of elastic air observed in chalybeate waters, in the more spirituous when recent, in others when the putrid smell shows the sulphur to be more disengaged?

Are not the different kinds of steel-waters to be prescribed, according as there is occasion for a subtil penetrating sulphureous spirit to pervade the smallest vessels, or according to the quantity of an absorbent astringent earth that is required to be joined with this spirit?

Where different spaws are not to be had, may not the same water be made to answer each of these intentions, according to its being more or less kept, or exposed to the air or heat?

REMARKS on the INTERCOSTAL MUSCLES.

TAUVRY * showed the misapplication of Mr Bayle's proposed demonstration of the action of the internal intercostal muscles, from his inattention to the ribs not keeping in the same parallelism when they are raised as when they are depressed, because of the greater motion of the lower than of the higher ribs; and he took notice of the same demonstration, proving equally that the anterior part of these internal intercostals must act in inspiration, as Bayle would have their posterior part to act in expiration. But neither he, nor any other writer of my acquaintance, has applied this demonstration of Bayle's; which, granting the parallelism of the ribs to remain the same, is a good one, to account for the defect of the internal intercostals between the spine and the angle of the ribs, and for the deficiency of the external intercostals from where the ribs begin to turn upwards to the *sternum*; a fact which anatomists are now all agreed in. The application of the demonstration to this purpose, is the intention of this paper.

Let AB (Plate VII. fig. 1.) be the spine, CD the sternum, EFGH and IKLM two ribs; then EK and GM are lines in the direction of the external intercostal muscles, and FI and HL are in the direction of the internal intercostals.—Now, says Bayle, if both ribs rise, the angle FEI must be enlarged; and its hypotenuse FI, the fibres of the internal intercostal, must be longer; whereas muscles generally are shortened when they act.—Near to the spine, where the ribs cannot be brought nearer at one time than another, this reasoning is just; and therefore the internal intercostals are not placed nearer to the spine than where the motion

* Anat. Raisonn. Part II. chap. 14.

of the ribs is large enough to allow the lower rib to approach so much to the one above it, as to do more than compensate for the elongation of the hypotheneuse of the angle FEI; *i. e.* the internal intercostal is only to be found farther forward than the angles of the ribs.

Near to the sternum, the cartilages cannot be brought nearer; and therefore when they are raised up, HL, the fibres of the internal intercostal, may be shortened, because the angle HMI is made less: But if there were fibres of the external intercostal here, as GM, they would be made longer; because the angle GHM is enlarged by raising the ribs; and therefore no external intercostal muscles are placed at this fore-part of the thorax.

Nº 48.

P R O O F S

O F T H E

CONTIGUITY of the LUNGS and PLEURA.

THE experiment of opening the thorax without hurting the lungs of living animals, while the trunks of their bodies are immersed in water, through which no bubbles of air rise after the perforation, as proposed by the ingenious Lieberkuhn, and executed by the illustrious Haller *, is a decisive one, if rightly performed, for proving no air between the pleura and lungs. But as an unwary operator may wound the lungs in perforating the thorax, when air would certainly rise in the water, from which the existence of air in the thorax might be concluded, and several other circumstances may, and have caused the conclusion from this experiment to be disputed; it may not be amiss to mention some easier ways of proving the non-existence of air in this place. Such are the following.

1. Dissect the teguments and intercostal muscles from the pleura of either a dead man or quadruped without wounding this membrane, in which there is no difficulty; then, pull up and depress alternately the sternum and ribs as often as you will, the lungs are seen contiguous all the while to the pleura; but on making a small puncture through this membrane, the lungs, if they are not grown to the pleura, which is often the case in the human subject, fly from the pleura, and are no more seen.

* Opusc. de Respirat.

2. This connection of the lungs and pleura, more or less of which is seen in most human bodies, implies strongly a natural contiguity of these two parts.

3. Lay bare the pleura, without wounding it, between two ribs of any living quadruped, which requires no great dexterity; and then the contiguity of the lungs and pleura may be seen, though the lungs are constantly sliding and changing place along the pleura, and though this membrane is in different states. While the creature inspires, it is concave; during expiration, it is convex and prominent outwards: for this plain reason, that while inspiration is performing, the air does not pass so quickly at the narrow glottis as to fill the lungs at once with air of density and weight equal to the atmosphere; and, during expiration, the air cannot escape so fast at the glottis as to prevent its more than ordinary condensation and expansibility in the lungs than the external air has.

If we were to find accurately what weight the pleura could raise when it is made convex during expiration in the preceding experiment, would not this determine how much more pressure, than that of the atmosphere, the part of the lungs within this elevated pleura, on which this weight is sustained, is exposed to?

Would not the pressure on the same part of the lungs, during inspiration, be nearly as much less than the weight of the atmosphere, as is the weight raised in expiration; since it is the same glottis which allows the air to pass in both cases?

Is not the force by which the inspiratory organs, acting with the greatest energy of the mind, exceed the power of the expiratory organs uninfluenced by the mind, considerably less than the weight of the atmosphere; since if, after expiration, we prevent the entry of the air by the glottis, we cannot dilate the thorax as in inspiration, though there is still a good deal of rarefying air in the lungs?

Do not the inspiratory organs, during inspiration, overcome the resistance of the expiratory organs, and likewise that share of the pressure of the atmosphere which the air, rushing into the lungs, does not balance?

Are not the ribs arched, and the spaces between them narrow, to prevent ill effects from that unbalanced part of the atmosphere during inspiration?

The CURE of a fractured TENDO ACHILLIS.

OUR predecessors were either not subject to the breaking or tearing the *tendo Achillis* ; or it was mistaken for a sprain, or some such other disease, by physicians and surgeons : for it is rarely taken notice of in books ; and the oldest and best practisers here assure me, they had not observed it, or heard of it, till between twenty and thirty years ago ; since which, this accident has happened to a considerable number of people of this country, of whom I know sixteen, and several of those have broke the tendons of both legs. Amongst the rest, I have been a sufferer this way ; and upon a comparison with my brethren in affliction, my cure is the most complete of any I know ; there being neither pain, stiffness, weakness, nor observable shrivelling, in my left leg where the *tendo Achillis* was broken ; whereas most of the other gentlemen have some of those uneasinesses, and several have all of them. On this account, I think it my duty, for the benefit of future patients, to make my method of management as public as I can.

When my tendon was torn, it cracked as loud as if I had suddenly broke a nut under my heel ; which the company believed had happened : and I had such a sensation, as made me imagine that the heel of my shoe had struck a hole in the floor, which is the feeling that several have had as well as I ; while others complain as if they had received a smart stroke with a stone or cane on the part. I suspected immediately what the case was : and therefore, after feeling where the hollow was, between the ends of the broken tendon, I took the left foot in my right hand, with which I extended the foot strongly ; and, as soon as I was put in a seat, pressed down the calf of my leg with my other hand : In which posture

I kept them till Messrs. John Douglas and James Ruffel, surgeons of this place, came; and after being satisfied of the rupture, by pressing their fingers into the hollow between the two ends of the tendon, they applied compresses, and a bended board on the upper part of my foot and fore-part of my leg, which they kept, as near as they could, in a straight line by a tight bandage made with a long roller.—This dressing became soon too uneasy for me to bear; and the board was liable to shuffle, whatever care was taken in the application of the bandage: therefore I changed it for the following compound one, consisting of two pieces. See Plate VII.; where

Fig. 2. Is a foot-sock or flipper, A, of double quilted ticking; from the heel of which, B, the quilted strap *c*, is of such a length as to come up above the calf.

Fig. 3 A strong quilted calf-piece L, with pye-holes MM on each side, through which a lace (fig. 4.) is to be passed; and with a buckle N, so placed on its back-part, that, when the lacing was on the outside of the leg, the buckle was in the middle of the lower part. Two rows of pye-holes are here represented on one side, either of which is to be used according to the thickness of the leg.

Having then wrapped soft flannel, smoked with the fumes of benzoin, round my foot and leg, I put on, as in fig. 5. the foot-sock A, and calf-piece L, and bringing the strap C through the buckle N, I could by it extend the foot, and pull down the calf to what degree I thought fit, and there secure it with the buckle.

This bandage answering my intention quite well, I wore it night and day; drawing the strap tighter when I inclined to sleep, and relaxing it when I was fully awake and on my guard: at which time, likewise, I placed my foot on a stool, in the posture represented at S; and frequently shifted the calf-piece, or made the lacing of it looser, to prevent the swelling of my foot, which it was in danger of occasioning when it became too tight by being drawn down by the strap.—After a day or two, I found my toes uneasy, from the foot-sock pressing them; and therefore I undid the sewing of it at the toes, from *d* to *|d*, and have caused it always since to be made open there for others who used it.

During two weeks, I made no motion nor effort with my foot; but
was

was carried in a chair, running on castors, from one part of my house to another. After this, I began to move the foot backwards and forwards so gently as not to give pain, and gradually increased those motions; but always stopped the flexion of the foot, or extension of the leg, whenever I felt the least uneasiness. Frequently I continued these motions for half an hour together with the diseased limb; but kept the other as much at rest as I could.

When I began to walk, I always put the left leg some way before the right, that the left foot might be well extended; making use of a cane in my right hand, to prevent any danger of falling.

The void between the two ends of the divided tendon became insensible in a few days, except that a softness was felt there more than any where else: but this part turned gradually thicker and harder, till a knot was formed in it; which one, in feeling through the teguments, would have thought to be a piece of cartilage as large as a middle-sized plum, which has greatly decreased and become softer for some years past, so that at present it is much less perceptible than formerly.

Some weeks after the accident, I began to pour cold water on my leg and foot, causing them to be well rubbed immediately after: but the water, instead of strengthening the member, as I expected it would have done, made it cold and weak; for which reason I soon forebore the use of it, and caused the leg to be rubbed twice a-day strongly with *unguentum altheæ*, or some such greasy stuff, to protect the skin from excoriation by the friction. This manœuvre was continued till I began to employ the limb freely.

Being obliged to go abroad after six weeks, I put on a pair of shoes with heels about two inches high, and applied the machine which I am just now to describe, in the day-time, instead of the former bandage; which, however, was always put on at night for a month more.

The new machine, fig. 6. was a piece of steel, the middle stalk of which A is narrow but strong. The ends BB are thin, broad, and concave, adapted to the convexity of the foot and fore-part of the leg. Three staples, *ccc*, stand up from the fore-part of the steel, one being in the middle of each of the broad ends, and the third in the middle of the stalk. All the steel, except the staples, was covered with chamois leather;

ther; and the concavities of BB were well buffed, as the softer rupture-bands commonly are.

After I had put on my shoes and stockings, one end of this machine was put on the broad part of my foot, nearer the toes than the buckle of the shoe; and the other end was placed on the fore-part of the leg: then one ribband, or a thong of leather, (fig. 7.) was put round the foot, and another (fig. 8.) round the leg, to pass through the two staples near the ends of the machine, and there secured with straps or buckles, but without being drawn tight.—A third strap or ribband, (fig. 9.) having its middle D applied in the hollow of the foot, immediately before the heel, had its ends passed on each side of the foot, through a sinus or noose EE, of a fourth thong of leather F, that came round the quarter-heel of the shoe, to be afterwards put through the middle staple; where, after these ends GG were drawn as tight as was thought convenient for extending the foot, they were secured with the buckle or with knots. (See the application in (fig. 10.) I wore this machine always in the day-time for five months; though, as it is inconvenient by shuffling out of its place sometimes, I think a thong of leather sewed at one end to the upper middle part of the quarter-heel of the shoe, and fastened at the other end to a garter put above the calf of the leg, would serve instead of it without inconvenience.—All that time I never walked the streets, but was carried in a chair.—In going down stairs, I always put the diseased leg first down at each step; and in coming up, I put the sound leg foremost: by which I shunned the stretching and retearing of the new-folded sinew, which I knew, from what others had suffered, might have made the case worse than it was at first.—The habit I had got of walking after this manner in stairs, became so much a second nature, that I had afterwards difficulty to learn to go up and down in the ordinary way with the feet alternately.

I continued the high-heeled shoes for two years, causing my boots to be made after the same fashion when I began to ride; but have gradually since retrenched their height, till now I wear them of the common make.

During all that time, too, I mounted my horse at the right side instead of the left one, that I might shun the rearing my whole weight, by the
force

force of the weakened gastrocnemii muscles ; and to prevent the accident of straining them in case the horse stumbled, I kept the left foot deep in the stirrup. In walking up-hill, I put that foot a-crofs ; and, in short, guarded against every other stretching step or motion.

On comparing the size of the calfs of the two legs at present, the left one is a little smaller than the right one, especially in the morning ; but so little, that it is scarce perceptible : through the day, the difference becomes less.—The *tendo Achillis* that was broken, is, as most other tendons cured after breaking, considerably thicker and harder than the other ; but one must be told it is so, before he can discover it by the eye.

Nº 50.

H I S T O R I E S

O F

Tophaceous Concretions in the Alimentary Canal.

1. **A** HEALTHY boy, about twelve years of age, began to complain of colic-pains ; which increasing with frequent gripes, *borborygmi*, and vomiting, had such an effect, that his parents asserted he was scarce of so large a stature, after six years of his disease, as he was at the beginning of it. Vomits, purges, vermifuges, attenuants, and a variety of other medicines, had been given in that time, without any benefit.

His father, one of the town-officers or serjeants, having then asked my worthy friend and colleague Dr Plummer's advice, he desired my assistance. We were told by the lad, who was greatly emaciated and very weak, that some years past he had not had the vomiting, but found a hard painful tumour above the left groin, which sometimes shifted place a little, where he fancied often he felt something like the striking of two hard bodies on each other. He had been of late much fatigued with tenesmus. Sometimes he had no excretion of fæces for several days ; and often he could scarce make any water, and that only in drops. During two days before our visit, the tenesmus was constant ; and he felt something hard within the rectum near to the anus, which he and several others had endeavoured in vain to bring away with their fingers.

On extracting this substance with a forceps, such as is used for extracting

ing stones from the bladder, he was much easier than he had been of a considerable time. Next day he passed two other balls; and on each of the two following days, a ball, which he could not force out at the *anus*, was extracted with the forceps. After this he had no uneasiness, and soon became a healthy young man.

The largest of these five balls, which was the first extracted, is five inches in circumference, and something globular, but with several prominences and flat surfaces. Most of the flat parts had a smooth shining tartarous thin coat; the rest of it was more rough, and of a spongy appearance. The two last brought away are less in bulk, and without so much tartarous crust. The two small ones are all covered over with the shining tartarous crust, which in several places is prettily variegated with different shades of an ashy colour. One of them has some resemblance in its shape to the shell of a tortoise: the other, or smallest, may be compared to two pyramids joined by a common base.

The second in size, and the smallest, are cut through near to the middle, where there is a small flat bone, that probably has been the nucleus about which these balls were formed, though they are not of the same shape.

We were informed by the parents, that they had often chid their son for swallowing the small bones of sheep and lambs feet; the sinewy parts of which, when boiled, the family frequently took for food.

2. A man who had been long tortured with a painful hard swelling in his belly a little above the right groin, which frequently caused vomiting and diarrhoea, though at other times he was very costive, asked my advice when he was very weak and emaciated. The seat of this tumour, the kind of feel it had through the containing parts, and its tumbling, as the patient said, from one place to another when he changed postures, made me suspect a concretion to be lodged in the great sac of the colon.

In hope to push it forwards in the colon, I caused his great guts to be filled with whey injected by the anus, and then directed himself and assistants to press repeatedly the tumour upwards. This manœuvre being several times renewed without success, I prescribed a brisk purgative, and ordered the injections with the pressure to be repeated as soon as the cathartic began to operate. But this and several other such operations failing, my patient died.

668 CONCRETIONS IN THE ALIMENTARY CANAL.

Having obtained leave to examine his body, my conjecture proved to be right; for in the *caput coli*, there was a ball of more than seven inches circumference, with a depression at opposite ends. The intestine had contracted so much at the side of the ball next to the cavity of the colon, that I could not force it through the aperture there, but was obliged to cut the sac in which it was lodged to take it out.

The ball had no tartarous crust on its surface: and when it was cut through, its nucleus was a chalky or limy substance about the size of a common pea.

3. Dr John Stevenson physician gave me a concretion six inches in circumference, the nucleus of which is a plum-stone, taken out of the intestines of a boy of five years old. Though the stone had been swallowed long before the boy's death, the kernel of it was fresh when the stone was taken from the middle of the ball. A clyster had brought away several other plum-stones from this boy some months after the plums had been eat.

4. Dr Stevenson also gave me another such concretion, which has four flat sides with several depressions in them, measuring about five inches in circumference, formed also on a burnet plum-stone, which he took out of the intestines of a girl.

5. From the same gentleman I likewise had a third concretion pretty like to, but a little larger, than the one described and painted by Dr Simson in Med. Ess. vol. i. art. 32.; which, with three such others, he took out of the intestines of another patient. Each of them had a small stone in the middle, the patient having formerly swallowed small stones and pebbles for what he called a colic in his stomach.

The Doctor tells me, that all these three patients wasted, without being sick or losing their appetite. They were fond of flesh for food, and were averse to slops. They seldom were free from *borborygmi*, which made the abdomen to change almost constantly its appearance, the parts of it rising and sinking as the air went from one place to another.

6. In a ball of this kind, eight inches one way and six the other, taken from a gentleman's intestines, whose history I do not know, the nucleus is a little round piece of wood about the size of a common hazle-nut.

None of the balls mentioned in these four last histories have any tartarous

rous crust ; but they and all the other cut ones have the appearance of being composed of strata surrounding the nucleus, their colour differing in shades from a dark rusty to a pale ashy colour. Their substance, except where there is tartarous crust, resembles a fine hat or chamois leather when cut.

7. In the collection of curiosities kept by the surgeons of this place, there is a ball taken out of the stomach of a horse, which is nearly spherical, and nineteen inches in circumference. Its surface has something of the mulberry form, being composed of a great number of hemispherical knobs, about a quarter of an inch diameter, contiguous to each other. Their outward shell looks like a thin crust of sandy clay ; but within this the substance has the same matted appearance as the human concretions have.

8. Balls are also frequently formed in the stomachs of cows. Three of them which were given to me, are almost exact spheres of a black colour, composed of an external hard tartarous crust, which is about one twentieth of an inch thick. Within this there is nothing but short black hairs matted compactly together. The circumference of the largest is 9 inches ; of the second, 6 ; and that of the third is $5\frac{1}{2}$.

N^o 51.

R E M A R K S

O N

PROCIDENTIÆ ANI, INTUSUSCEPTIO, INFLAMMATION, and
VOLVULUS of the INTESTINES.

AT stool, more or less of the inside of the *rectum* is generally thrust out beyond the verge of the *anus*, which ascends when the pressure of the diaphragm and abdominal muscles ceases. If the protruded intestine is not then retracted, it is squeezed by the *sphincter ani*, so that the return of liquors from the part of it which is beyond this stricture must be rendered difficult; on which account, this part swells, becomes of a colour more red than natural, and a larger than ordinary quantity of slime flows from the ends of the vessels that open on its inverted villous surface. This state is called *procidentia ani*; a disease to which children, old people, those weakened by diseases, or such as are attacked by *tenesmus* from whatever irritating cause, are more subject than others.

The speedy reduction of the inverted protruded part of the intestine, is the effectual cure; nor should time be lost, as is often advised, in trying to diminish the swelling by warm fomentations and poultices; which relax the vessels, and rarify the liquors, and therefore produce an effect very different from what they are intended to have. If the prolapsed intestine is so much swelled, that it cannot be made to pass through the contracting sphincter, incisions may be made in its surface, by which part of the slime and blood contained in the cellular membranes may be squeezed out to diminish its volume, and thus to make it capable of returning again within the body.

The

The practice of the nurses and other good women, in making the reduction of a *procidentia*, is very faulty. They apply a warm cloth to the protruded part of the gut, and pressing on it endeavour to thrust it all up at once. Before the intestine swells, this operation sometimes succeeds with children whose sphincter is weak. But dry cloths or fingers are liable to adhere to the villous coat, and give great pain in taking them off. The cloths or fingers applied here ought always to be besmeared with oil, unsalted butter, or axunge, to prevent this adhesion. The bulk of the prolapsed part is often so great, that it is impossible to make it all pass at once through the sphincter, and a fruitless attempt of reduction generally increases the swelling. The reduction ought to be made by pressing a small part of the sides of the orifice, with a greasy finger; and when that part is thrust within the orifice, another finger is applied to what is then the verge of the orifice to push it upwards, while the first applied finger is withdrawn: by such an alternate succession of two fingers, the whole may be introduced in most cases without incisions, so that this disease is seldom fatal; and for that reason, the patient is generally too much neglected after the reduction is made, which is sometimes attended with bad consequences.

If, after the reduction, the part continues to be pained, and the patient's pulse is quick, blood-letting and a low and cooling diet are necessary to prevent inflammation and its consequences. In all cases, too much costiveness, and its contrary a diarrhœa, especially with *tenesmus*, are equally to be guarded against; seeing a return of the *procidentia* may be caused by either of them. The relaxed parts are to be braced by strengthening topical medicines. In the astringents commonly prescribed, I can have no confidence; their effect goes no deeper than the skin: but stimulants, such as ardent spirits, or tinctures of the aromatic resins made with them, give a spring to all the parts, and excite a glowing heat whenever they are applied so as to touch any part of the extremity of the gut, which they can always be made to do.

I have said that this disease, the *procidentia ani*, is seldom fatal; and the reduction of the prolapsed part of the intestine into the body is generally regarded as a cure of it: but that this is not true, when the doubling of the intestine is high up, will appear from the following history.

A large-sized strong healthy boy, a year and an half old, after a diarrhœa of some days, with tenesmus, was observed to have a *procidentia ani*, which was treated two days by the women who attended him; after which Mr Adam Drummond, surgeon in this place, was called to his assistance. He reduced the *procidentia* frequently; but it soon returned, which made him desire I should be consulted.

The inverted intestine stood out four inches from the *anus*, without being much swelled or of a deep red colour, and the child seemed to have no other disease. Mr Drummond most easily introduced all the tumour into the body; but soon after it was pushed out again, upon the child's having a desire to stool, notwithstanding a servant's keeping a finger on each side of the *anus* near to each other, while some liquid excrement was passed. After the reduction was again made, I put my finger which is long up the *rectum*, pushing the orifice of the inverted gut on the point of it; and then found the orifice of the inverted gut resembling the feel of the *os tinæ* of an unimpregnated womb resting on it, which I could throw up some way further with a sudden jerk of the last point of the finger, but without being able to invert it. We then caused a large quantity of milk and water to be injected with force, while the two sides of the *anus* were pressed firmly on the pipe of the syringe introduced by the *anus* into the *rectum*, to prevent the liquor's recoiling, in hope that the liquor would carry the inverted gut before it, to cause its return to the natural situation. This operation being repeated several times in vain, the *procidentia* always returning with the *tenesmus*, a very long probe of whale-bone was made, sponge was fastened round the probe, and this was wet in oil; the probe was introduced into the orifice, which, I said, resembled an *os tinæ*, the sides of which rested on the sponge; and with this the intestine was pushed a great way up into the body in the direction of the *rectum*, but without success. Several attempts of the same kind failing, we despaired of a cure; and the child, some time after, being attacked with severe vomiting and perpetual *tenesmus*, died in a few days.

Mr Drummond, who opened the body, told me, that the inversion began a little below the upper part of the sigmoid flexure of the colon; and that the mesocolon was torn away from the inverted part.

When a doubled part of an intestine is extended into the cavity of this
alimentary

alimentary canal, without appearing externally at the *anus*, it is called *intusceptio*, which I am persuaded is a much more frequent disease than is generally thought. I have seen several whom I judged to have died by it, and shall now relate the cases of four people whose bodies were examined after death.

1. A middle-aged woman, during sixteen months before her death, suffered greatly from colic-pains, distension of her belly, vomiting, and *tenesmus*. In the latter part of her life, when I first saw her, she had no cessation from pain, except by the force of *opium*.

In the great arch of the *colon* was a doubled part of that gut, seven inches long. The containing intestine had a very slight adhesion to the inverted doubled part contiguous to it. The doubled part was of a dark red colour, but not very hard. The passage for the *feces* through it was very narrow, not allowing a finger pushed with force to pass.

2. A woman about fifty years of age lived two years with such symptoms as were narrated in the preceding case. We found a doubled part of the *colon* four inches long in the left loin, with the same appearance as described in the former history.

3. A girl seven years old, after eating a carrot and some currant-berries, had a colic, which continued, with a distended belly, vomiting, and passing little *feces*, from July till the middle of December, notwithstanding various medicines were given.

Mr Malcolm Surgeon in Dalkeith, whose patient she was, being allowed to open her corpse, cut out the affected part of the intestine, and sent it to me. The end of the *ilium*, *valvula Tulpii*, *caput coli*, and *appendix vermiformis*, were raised twelve inches within the *colon*, to which they had a slight adhesion. The outer surface of the contained intestines was dark coloured, and very unequal. The orifice of the prolapsed part was not at its end, but at one side an inch and a half from the end, with a soft flexible prominence at each side of the aperture, which I judge to have been *Tulpius's* valve. The doubled parts were so grown together, that I could not distinguish one from the other. The passage within them was so small and crooked, that I could not push a probe through it; but, cutting it open gradually, I found it was still pervious.

4. Dr Cullen, Professor of Medicine in the University of Glasgow, communicated the following case to me.

A boy about twelve years of age complained of wandering colic-pains, which he imputed to blows received on his belly from some of his companions. These pains returned frequently, with *diarrhæa*, and sometimes bloody stools, for near a year, when his parents consulted Mr James Muir surgeon in Glasgow about him. The boy was then much emaciated, had a quick pulse, and was so weak as to be confined to his bed. Two weeks after this, a livid membranous substance, passed by the boy at stool, was brought to Mr Muir; who, observing it to be tubular, tied one end of it, and, blowing into the other, distended it into such a convoluted tube, thirteen inches long, as represented A B C, fig. 11. of Plate VII. which I caused to be drawn from the original which was sent me. As it has the mesentery D connected to all its concave side, it appears to have been an entire piece of gut, and not the villous coat only. Besides this large portion of intestine, there were several shreds and smaller pieces passed by the patient; notwithstanding which, Mr Muir saw afterwards among the the boy's *fæces*, skins of potatoes which he had eat after these parts of the intestine came away, so that they had not made any discontinuity in the alimentary canal. The symptoms continuing, the boy died in six weeks.

Mr Muir opened the body of his patient, in presence of several gentlemen of the faculty; who saw what I am now to describe, with the assistance of a figure, which I caused to be taken of the dried preparation of the intestine sent me.

The folds of the intestines and *omentum* were all glued together by a fatty curdy matter. Within four inches of the valve of the *colon*, the *ilium* A B C, fig. 12. Plate VII. formed into the usual curve by the mesentery D, suddenly rose perpendicularly at E, where it was much contracted and had the appearance of a cicatrice. When the intestine was opened, this contracted part of it was found much thicker and harder than it was any where else, especially on one side, where it stood so far into the cavity as to leave a very small passage for the aliment. Along this contracted part, the mesentery F was firm and thick. After this, the intestine G became of a natural enough form and make.

The gentlemen in Glasgow were, I think, justly of opinion, that the
part

part of the intestine inflated by Mr Muir, delineated fig. 11. was an intusufcepted part fallen away by gangrene from the intestine at E in fig. 12. where, if there was a concretion, as is related in case 3. it might have separated without leaving any discontinuity in the alimentary canal.

I have several times seen an *intusufceptio* in the small guts of children, a little below which I observed several worms; but the inverted part was neither swelled nor discoloured, which made me think this disorder had happened soon before death. In one of them a *lumbricus teres* had passed the half of its length through a hole made in the gut; but, as there was no redness or other mark of inflammation at this part, I judged the perforation to have been made by the worm after the death of the subject.

There is little difficulty in conceiving how a piece of a gut should enter doubled into the part below it, and how it may be gradually protruded downwards to a considerable extent by the food or fæces in their descent towards the anus: but it is not easy, when this disease begins, to distinguish it from a variety of other disorders which happen in the alimentary canal; or to find a remedy when it is suspected, especially if the intusufceptio is in the small guts: and from the observation above narrated of the child with the fatal procidentia ani, it would appear difficult to cure it; nay, if the doubled parts of the intestine are grown together, as in most of the histories, a reduction of it is impossible. Nature seldom will perform what I imagine she did in the last case, separate the doubled part, and unite what contained it. Nor do I believe any will be so hardy as to advise the amputation of the affected part of the gut.

It is surprising how the people in the preceding histories lived so long as they did, with such large doublings of the intestine, and its mesentery pressed together within another piece of intestine, when the common inflammation of the intestine often kills soon those it attacks; of which I could give numerous examples, but shall relate only one. A gentleman of weak nerves, and subject to flatus and pain in his stomach, was seized with a colic-pain about ten o'clock at night, for which he swallowed a small quantity of an ardent spirit. At three in the morning, twelve or fourteen ounces of blood were let from a vein in his arm, and a laxative clyster was injected, and operated well. At eleven that forenoon I first saw him, when his friends thought him much better, being free of pain;

but as his belly was greatly swelled and very tense, his pulse quick, small, and intermitting, his eyes languid, his countenance faded, and a cold clammy sweat was over all his body, I made the prognosis of his having very few hours to live. He died before five of the afternoon, so that his disease killed him in eighteen hours; and I have heard of others who died in less than twelve hours after the first appearance of inflammation.

The common practice of taking spirituous liquors, or the warm carminatives, when people feel colic-pains, is often unlucky, and public warning should be given against it; for tho' relief is found from such things in the windy or spasmodic colics, which is not a deadly disease, yet they hurry on the inflammatory ones so fast, that they soon prove mortal. I must likewise think, that writers on the inflammation of the intestines do not represent strongly enough the languor and low small pulse which such patients generally have more than in most other diseases. It is such that I have seen several cases where people of skill, deceived by these symptoms, have been afraid to order blood-letting, lest the patient had not strength to bear it, and thereby neglected this evacuation till it was too late. When there is a fixed pain in the stomach or intestines, with a quick though small pulse, no time is to be lost; blood ought immediately to be let plentifully, and venesection should be repeated till the pulse becomes full and free, which is a hopeful sign of a cure's being made, tho' neither pain nor fever have yet ceased.

The intusussceptio or inflammation, but especially the latter, is generally the cause of what is commonly called the iliac passion or *miserere*; for the volvulus or twisting a part of the intestines into a knot, which was formerly said to be the case, is generally thought now, when anatomy is more cultivated, and inspection of morbid bodies is more universally allowed, to be an imaginary evil.—See *Essays and Observations Physical and Literary*, Vol. II. Art. xxviii.

Fig. 4.



Fig. 2.

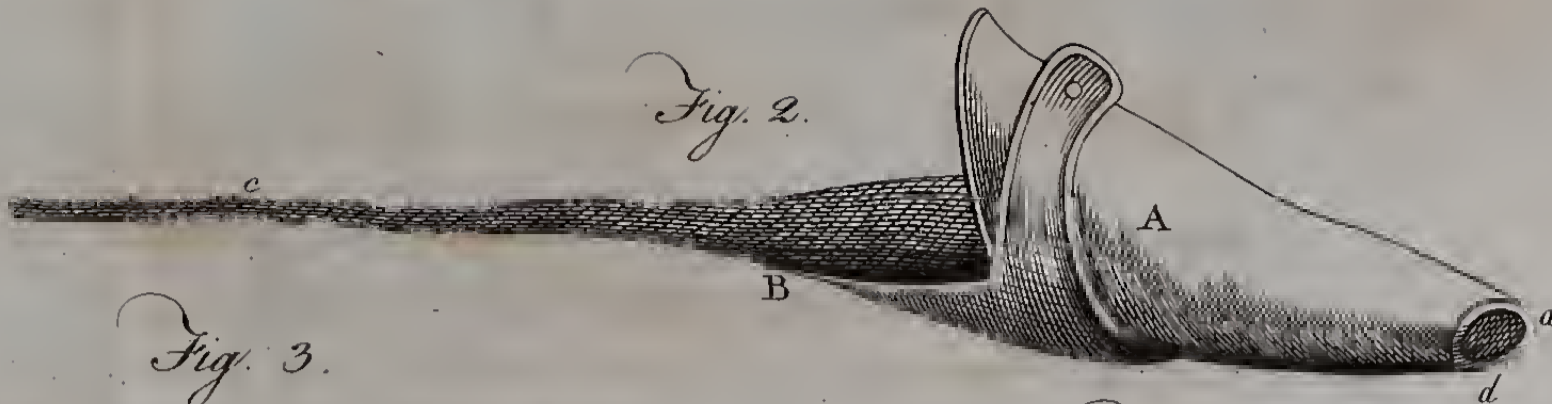


Fig. 1.

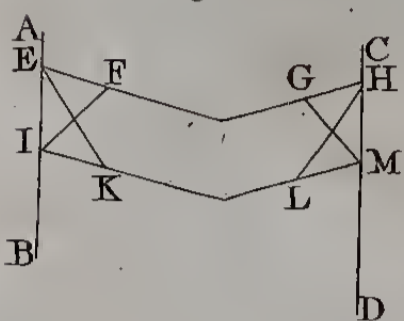


Fig. 3.

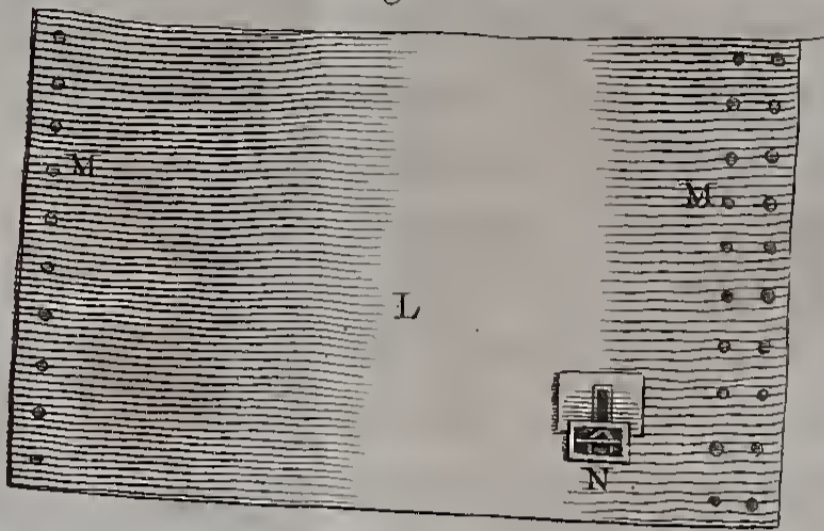


Fig. 11.

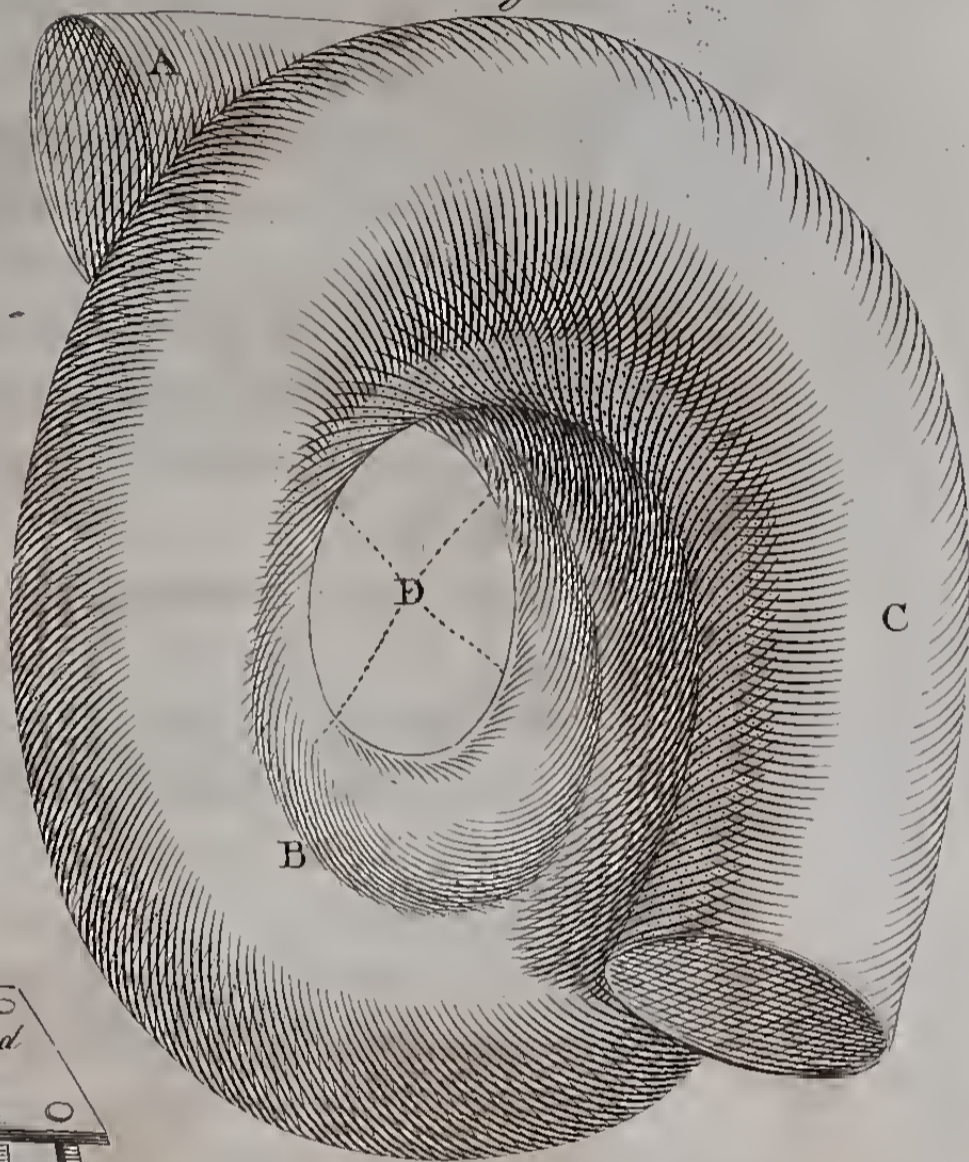


Fig. 5.

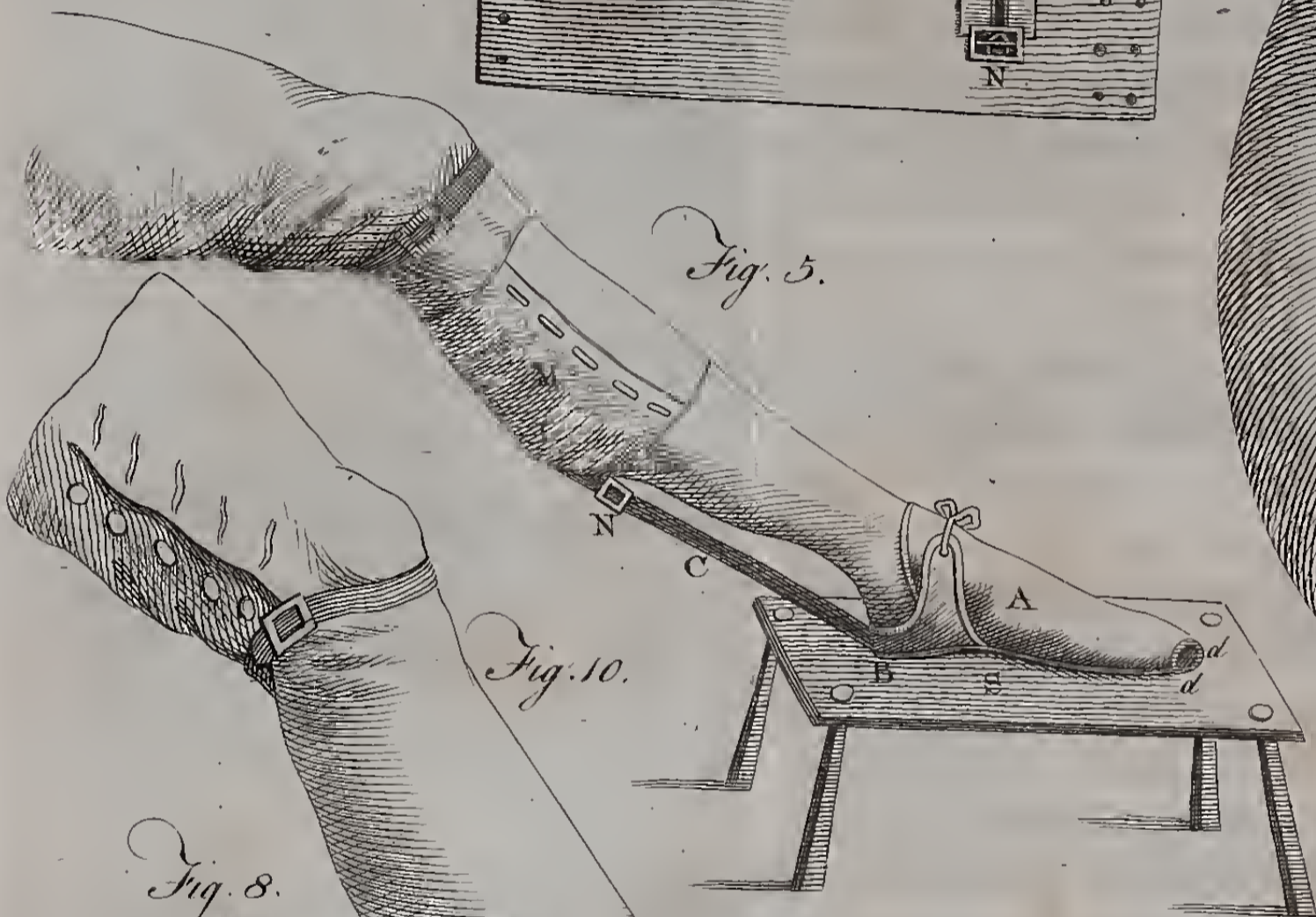


Fig. 10.

Fig. 8.

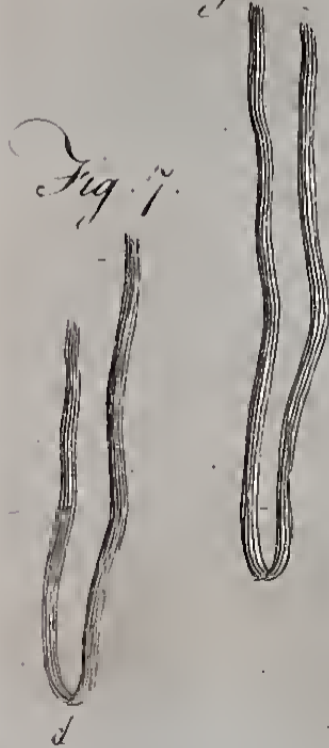


Fig. 9.

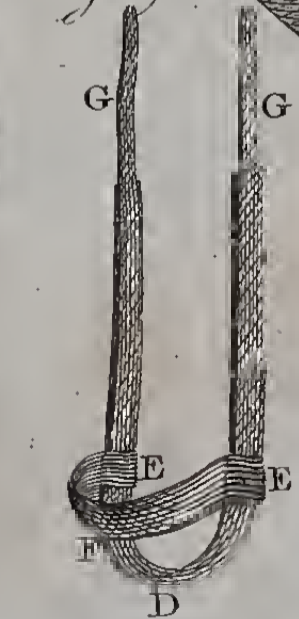


Fig. 12.

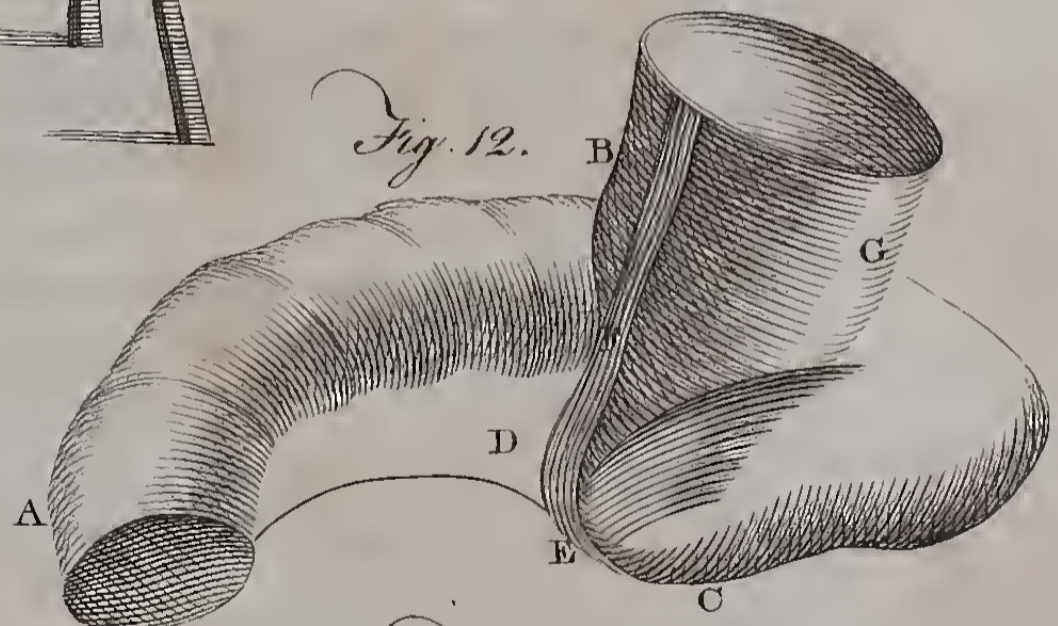
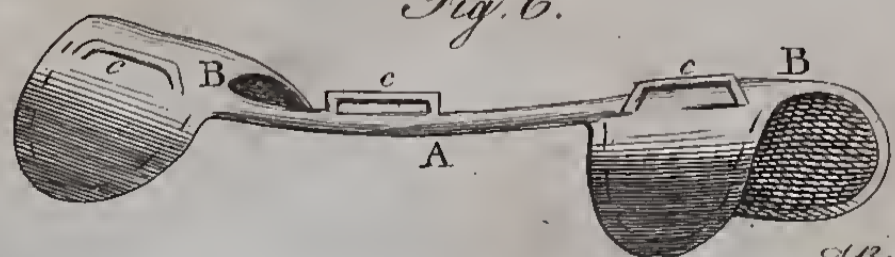


Fig. 6.



At Bell's Sculp.

A CHILD escaping at a RENT of the WOMB into the ABDOMEN.

IN March 1744, I was desired by Mr Ramsay surgeon here, to witness the examination of the body of a woman who died in child-labour without being delivered. The account given me of this woman was, that she was about 35 years of age, and had born two dead children, and a living one. Being at her full reckoning, her pains had begun on Tuesday morning, and continued in a natural way, the child advancing towards the birth, and some of the waters coming away all that day and Wednesday, till Wednesday evening, when, sitting in a chair in labour, she gave a sudden spring from the chair, complaining of violent pain in her belly. The child never was felt afterwards by those who attempted to assist her delivery. She constantly complained of violent pain in her belly, with her senses and judgment entire, till Friday morning, when she died. On Saturday her body was opened.

After cleaning away with sponges a considerable quantity of blood floating in the abdomen, we saw a ripe child and its secundines lying in the lower part of it, a little to the right side. The child, placenta, and umbilical rope, were entire, and the membranes were as usual after birth. The woman's uterus had its fundus raised as high as the navel, with its substance soft and spongy as is common in pregnant, nothing preternatural appearing in its fore-side: but when the fundus was turned down and forwards towards the ossa pubis, a large rent four inches long was seen towards the neck of the womb; which being again put into its natural situation, was opened its whole length, in the middle of its fore-part, when we had a better view of the rent, extending from very near
the

678 CHILD ESCAPING AT A RENT OF THE WOMB.

the *os uteri* upwards, a little obliquely to the right side. The *os uteri* was then very little open. The *cervix*, which is distinguishable plainly from the *fundus* in a woman not with child, was here extended into the same common sac with it. The inner surface of the womb was all smooth, seeming to be covered with a fine villous membrane. From the larger size of the sinuses at the back and upper part of the womb, I judged the placenta to have been formerly applied there.

Nº 53.

Nº 53.

A C C O U N T

OF THE

INOCULATION of SMALL-POX in SCOTLAND.

To the Most Worthy DEAN, and Learned DELEGATES, of the Faculty of MEDICINE at Paris, appointed to inquire into the Advantages or Disadvantages from INOCULATION of the SMALL-POX.

LEARNED GENTLEMEN,

IN the beginning of November last, I received the letter, dated in September, which you did me the honour to address to me, desiring my answers to five questions you propose concerning inoculation of the small-pox, to assist you in forming a right judgment of the advantages or disadvantages of that operation.

As I thought this a subject of such consequence to mankind, that it was every person's duty to contribute all in his power towards ascertaining the good or bad effects of its practice, I immediately communicated the contents of your letter to all the physicians and surgeons of this place, and wrote to gentlemen of medical practice in the different counties
of

of Scotland, whose assistance I begged to have in forming proper answers, to which my own private knowledge was altogether inadequate.

By looking at the table inserted in the answer to your second question, you will see what a public spirit my countrymen have shewed: and I am persuaded, it is my fault that that table is not more complete, by my omitting to inform many other medical gentlemen of your desire; which I flatter myself will be imputed to my want of memory, or knowledge of their names and residence.

One intention of mentioning here this general correspondence, is to plead some apology for my answer to your letter being so long delayed.

Q U E S T I O N I.

Has Inoculation been long practised in your country, and with what success?

Here are two articles which require to be separately considered.

In answer to the first of these, to wit, *How long has Inoculation been practised in this country?* I shall relate the history of its practice here.

The inhabitants of Scotland generally have the small-pox in their infancy or childhood; very few adults being seen here in this disease. Whether this is owing to any particular constitution of the air, or of the people, or to the disease not being so much dreaded as to cause any to fly from the place where it is, or to the great intercourse which must be among the inhabitants in the towns, of which several, nay many families, enter to their houses by one common stair, while in the villages the peasants are generally assistant to their neighbours of whose family any is sick, it is not now necessary to inquire.

When small-pox appear favourable in one child of a family, the parents generally allow commerce of their other children with the one in the disease: nay, I am assured, that in some of the remote highland parts of this country, it has been an old practice of parents whose children have not had the small-pox, to watch for an opportunity of any child of their neighbours being in good mild small-pox, that they may communicate the disease to their own children, by making them bed-fellows to
those

those in it, and by tying worsted threads wet with the pocky matter round their wrists.

The operation of inoculation, as now practised, was not however known in this country, till Mr Charles Maitland surgeon, after making trials on criminals, and successfully inoculating the children of the Royal family at London, introduced this practice into England: and then returning to this his native country in 1726, went first among his relations in Aberdeenshire, where he inoculated six children of gentlemen; of whom one labouring under a hydrocephalus, or water in the head, concealed from the operator, dying, there was such a prejudice raised against this practice, that it was banished from that part of the country during the subsequent twenty years, and with difficulty was again introduced there by Dr Rose physician at Aberdeen.

In the same year 1726, Mr Maitland inoculated four children of a noble family in the west of Scotland, who all recovered well; while a fifth child of the same family, who was thought too young and weak to undergo this operation, being sent to a distance before the other four were inoculated, there took the natural small-pox and died.

The first place, however, where the practice of inoculation became frequent was Dumfries, a town where the natural small-pox were generally of a remarkably bad malignant kind. Here it was begun about the year 1733, and has been employed ever since that time.

Gradually it was introduced into the other parts of Scotland; but so slowly, that most of those in the table inserted in answer to Quest. II. were inoculated during the ten or twelve years preceding 1764.

The first and most general prejudice against inoculation, was its being deemed a tempting of God's providence, and therefore a heinous crime; for it was creating a disease by which childrens lives might be in danger. But parents who had lost several children by the natural small-pox, considering the probable advantages which artificial infection, by *giving the choice of the age and state of the patient, of the season, and the management as to diet, exercise, &c. before the small-pox form*, has over the common natural way of catching this disease, and seeing the success of it in their neighbourhood, looked on it as a salutary means of saving their childrens lives; and therefore, thinking the neglect of such means to be criminal, had ino-

culation performed in their families *. The greater number of the gentry, and most of the medical gentlemen, see the latter scruple, or neglecting what they think proper means, in the strongest light, and have their children inoculated; but the former one, the tempting of Providence, weighs more among many of the populace, who will not allow the small-pox to be artificially implanted.

According to the one or the other of these two opposite ways of thinking; prevailing in different parts of this country, inoculation is admitted or refused; and this probably is one principal reason of the difference of the numbers in the table already referred to.

The scruple of tempting Providence being thus opposed, and in a manner balanced, by the other, of neglecting salutary means; those averse to inoculation now insist on other considerations, which they think should determine us against such practice.

1. Inoculation, say they, may, and probably does, introduce small-pox where they would not otherwise come, and therefore should not be allowed.

The answer given to this argument by the opposite party is, That since very few of mankind now escape this disease, it must, sooner or later, come to every place; and therefore, if it is true in fact that a much greater number lose their lives by the natural than by the artificial infection, it is of more service to introduce the small-pox in a favourable way and season, than passively to allow them to destroy multitudes: and they add, that on a comparison of those who have died of inoculated small-pox, with those who have died of this disease taken in the natural way, it is evident that there is a much greater proportion of the latter than of the former.

2. To invalidate the force of the preceding argument, That the small-pox must come, sooner or later, to every place, the opposers of inoculation insist, that since this disease was only introduced into Europe about a thousand years ago, it might again be banished from it, by carefully guarding

* Several of my correspondents have sent me histories of families, where the parents, having lost several of their children by the natural small-pox, caused all their subsequent children to be inoculated, without losing one; and who are all alive after several years since the inoculation.

guarding against the introduction of infection, or by medicines which might destroy or change the parts of the human liquors that serve as fuel to the fiery poison of the small-pox.

Their antagonists readily admit, that the banishment of the small-pox would be of the greatest benefit; but they think the execution of it impracticable. For if it were proposed to be done by excluding from society all who had any chance of a cause of infection about them, commerce among men would soon be entirely put a stop to; and even from what is seen in countries where there seems to be very little chance of infection being conveyed by such communication, the small-pox rage: Thus in our island of Shetland, where none arrive except after a voyage at sea, and these are generally adults, who have already undergone this disease, it often is most general and violent.

If, to prevent contagion, a law was made, obliging all infected with this disease to be immediately put into hospitals at a distance from other houses, this could not be done in proper time to those infected in the natural way: for the infection is generally communicated some days before any symptom of the disease appears; nor can the fever preceding the small-pox be always distinguished from any other.

If the seeds of this disease could be destroyed by medicines which would not hurt the human constitution, the inventor of them would be a most universal benefactor to the human race; but unluckily there is not yet any such known. Boerhaave's antimonial and mercurial medicines, the antiphlogistic method, Lobb's Æthiops mineral, &c. have been tried without having the desired effect *.

3. Several think, that by the bills of mortality containing as great

4 R 2
numbers

* Juniper being a plant unsuspected of having any thing poisonous in it, there could be no harm in making some experiments with it, on account of the two following facts communicated to me. A lady, when the small-pox raged in her neighbourhood, bathed all her children daily in a bath made with juniper, and burnt juniper-wood in their rooms. Not one, of eight or nine children thus used, ever had the small-pox, though, when adults, several of them attended their own children while in the disease.—On my telling this to a gentleman, he asked me, if this might not possibly be the reason why none of a parish where juniper grows in great quantity were infected by the plague, so destructive to Scotland about the time of the Restoration, while the neighbouring parishes suffered greatly? which he assured me he had been well informed was fact.

numbers since inoculation was introduced as they did formerly, it may be concluded, that there is no saving of lives by this operation.

To this the following answers are made.

[a] From observation and plain facts, it can be demonstrated, that the proportion of those who die by inoculated small-pox is much smaller than of those who suffer this disease in the common way; and several of my correspondents affirm, that, after a strict inquiry, they are certain, a greater proportion of those who recovered from the small-pox after being inoculated, are in life and well, than of those who received the infection without art.

[b] Inoculation has not hitherto been so general in any place as to make a considerable annual difference in the bills of mortality.

[c] In considering these bills, a variety of other circumstances must be attended to: such as, whether more inhabitants have resorted to the place, or retired from it;—whether there have been more or fewer dangerous epidemical diseases;—whether the provisions have been equally good in the years when comparisons are made, &c. &c.

As the disputants of both sides would probably wish to see some examples of these bills, I shall give a table of the burials in the Grayfriars church-yard, where the dead of this city, Edinburgh, are interred; and of St Cuthbert's, or the West-kirk yard, where those of the suburbs and part of the country in the neighbourhood are buried, subjoining the number of those among them who died of the small-pox.—In this table I have put in one column the ten years before inoculation was much practised here; and in the opposite column are the subsequent ten years, when it has been more frequently, but far from being generally, performed, as is evident from the table itself, compared with the first article of the table of inoculated, in answer to Question II.: for from this it appears, that 713 only have been inoculated in Edinburgh and Leith, of whom ten died; whereas in the table of burials in the two cemeteries mentioned, there have been 1185 burials of those who died of small-pox during the years when inoculation was most frequent, which shews that a very small proportion of those who had small-pox was inoculated.

Years.

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Years.	Total of Burials.	Dead of Small-pox.	Years.	Total of Burials.	Dead of Small-pox.
1744	1345	167	1754	1215	104
1745	1463	141	1755	1187	89
1746	1712	128	1756	1316	126
1747	1200	71	1757	1267	113
1748	1286	167	1758	1001	52
1749	1132	192	1759	1136	232
1750	1038	64	1760	1123	66
1751	1241	109	1761	903	6
1752	1187	147	1762	1305	274
1753	1105	70	1763	1160	123
	<hr/>	<hr/>		<hr/>	<hr/>
	12709	1256		11613	1185

From this table we are informed, that in each of these ten years, about one tenth of the dead in Edinburgh and St Cuthbert's parish were killed by the small-pox.

What the number was of those who recovered from the small-pox I could not obtain information; and therefore cannot ascertain what the proportion is of those who die in this fatal disease, to those who recover out of it *: but from the Edinburgh and Leith article of inoculation above-mentioned, and this table, one may be convinced, say the friends to inoculation, that a much greater proportion die by natural than by inoculated small-pox; for by dividing the sum-total of the burials in these twenty years by the number of years, there are 1216 inhabitants of Edinburgh and St Cuthbert's who die each year. If one twenty-eighth inhabitant dies yearly, there are in these districts 34,048 people; or, if one thirtieth person only dies, the number is 36,480. Now, if the number of those who recovered is to the 1185 who died of the small-pox in the last ten years in the same proportion as in those who were inoculated, which is nearly as 71 to 1, then the number who suffer the small-pox every

* It is hoped, that when the Reverend Clergy are informed how satisfactory the knowledge of the proportion of those who recover from natural small-pox is to those who die of it, will be to numbers of people who wish to compare them with the proportion of the inoculated, they will shew the same public spirit as the medical gentlemen have done, and transmit to me the numbers of their parishioners who survive the small-pox or die in them, that I may publish them as an appendix to the present work.

every year is 8413; that is, near to one fourth of the inhabitants; which cannot be supposed of a disease which people have only once in their lives.

From the above table of burials, it would seem, that the total number of burials, as also of those who died of the small-pox, has been fewer in the last ten years, when inoculation has been more frequent than formerly: but this decrease, especially of the total number, might possibly be owing in part to the greater number than usual of men who then went from this place to the army and navy in the late war; whereas the burials were increased in the preceding ten years by those who died here of their wounds received at the battle of Preston in 1745, and by the mortality from the malignant putrid fever which the soldiers quartered in town had some time after that, and which they communicated to several of the inhabitants. Hence in the preceding table, the total number of burials is much larger in 1745 and 1746 than in any other two years of the twenty in that table; while the numbers of those who died of the small-pox during these two years is near to the middle proportion of all the other twenty years, but larger proportionally than the sum of the last ten years: which last circumstance seems favourable for inoculation; while some of the preceding observations shew how necessary it is to consider the different circumstances in calculations, such as I have been now mentioning.

4. The fear of communicating other diseases than small-pox, by the application of variolous matter when inoculation is performed, has deterred many from allowing this operation.

This objection must be considered in the answer to your Question V.; where it is directly asked, Whether other diseases have been thus communicated? and therefore I must here refer to my answer to that question.

Having thus stated the principal arguments employed for and against inoculation, I shall not draw any conclusion, but leave the determination of this affair to better judges, who are appointed by public authority for this purpose, and proceed in my historical narrative relating to this country; to which I am to confine myself entirely, in all the parts of
this

this answer to the questions proposed by the judicious Delegates, without pretending to give any argument or opinion of my own.

Those who advise and practise inoculation in Scotland have generally avoided to let it be performed on children whose parents were unhealthy, or who had themselves a bad constitution, or who were labouring under other diseases, or even eruptions on the skin: and some will not allow inoculation while there are confluent malignant small-pox frequent, or any other disease is very general; but cause great care to be taken in avoiding infection till a season of the mild distinct small-pox comes, and no epidemic disease rages.

Several, considering how much more liable very young children are to convulsions (the most frequent dangerous symptom in the inoculated small-pox) than those farther advanced in life, decline performing inoculation to very young infants.—While others think this disease commonly more favourable soon after birth, before there is any chance of its interfering with teething, which is another frequent cause of convulsions; and therefore advise inoculation to be performed early in life *.

Mild weather being generally allowed to be the most favourable in feverish disorders, inoculation is commonly performed in the spring, or beginning of summer, and in harvest; so as to avoid the sultry heat of summer, or freezing cold of winter †.

These precautions are not, however, always observed; the importunity of parents, the greater hazard from natural infection when it cannot be sufficiently guarded against, and a variety of other circumstances, have prevailed over practisers to inoculate children, notwithstanding some of the objections above-mentioned being applicable to their cases.—What
my

* That a more certain judgment may be formed of the time of life when children are most exposed to convulsions from inoculation or natural small-pox, I must beg my medical correspondents to send me the ages of the children, their patients, who underwent convulsions which they judged to be owing to small-pox. It is of importance to be known; and the practice of no single person can so well determine it, as numerous observations can.

† I have, however, good information of 112 being inoculated in the middle of winter, in some of our most northern isles, where there was scarce fuel enough to prepare victuals, and many of the inoculated went abroad bare-footed in snow and ice; yet not one of the whole number died.

my correspondents complain most of is, the parents or relations not allowing inoculation to be performed till they see the natural small-pox very frequent and mortal in their neighbourhood, when they absolutely insist on its being done.—Some of my friends write me, that notwithstanding this disadvantage of the bad natural small-pox being in their neighbourhood, they have had the pleasure of seeing all their inoculated patients recover, while scarce one of three, or even of ten, was saved of those who had the small-pox by natural infection.

When inoculation was first introduced into this country, those who were to undergo it were prepared for the operation by blood-letting, purgatives, aperients, and low diet: but the gentlemen of practice observing that the eruption did not proceed so well in children thus weakened, as in those who had not undergone evacuations, they are now generally omitted; and a mild cooling diet to the patient, or its nurse, with a gentle laxative to empty the intestines, are the principal preparations.—Some however give *Æthiops mineral*, or such other very inactive preparation of mercury, previous to inoculation; and think that thereby the violent symptoms of this disease are prevented.

The purulent matter employed for inoculation is taken from healthy children of sound parents, then under the distinct, mild, fully-suppurated small-pox, and as recent as it can be obtained.

When inoculation was first practised here, the operators made incisions through the skin in more than one part of the body, and then filled the little wounds with cotton or lint wet with pocky matter: by which they thought two good intentions were answered; *first*, to make the effect of this matter in producing the expected disease certain; and, *secondly*, to discharge a considerable share of the variolous matter, formed in the patient's blood, by the suppuration at these parts being plentiful, which freed them from more dangerous effects of the small-pox. But this practice being blamed for the tumours, inflammations, and tedious suppurations, which sometimes came after these wounds thus treated, a slight scratch is now generally made in the skin of one arm, into which a little piece of small thread passed through pocky matter is put, and kept there some days by a bandage, which is found as effectually to produce the disease of

a mild kind, and does not so often swell, inflame, &c. as when the former method was followed.

Possibly still gentler methods will be used: for we know that inoculation has succeeded when the pocky matter was applied to the surface of the skin from which the scarf-skin had been taken by a very small bit of blistering plaster.—In a letter transmitted to me, a gentleman informs me, that he gave the small-pox of a good kind to a child by rubbing a little recent pocky matter on its sound skin.—To confirm what I mentioned formerly of the Highland practice of communicating the small-pox, I have received from a good hand the history of a person in the Isle North Uist, entirely ignorant of medicine, who, being informed of the success of inoculation in Sky, and seeing the small-pox generally very favourable, put threads thro' some variolous pustules, and applied them to the arms of two of his own children; who having mild distinct small-pox, he made use of the matter from them, in the same manner, to the children of several of his neighbours; who all recovered from the small-pox without any bad symptom.

Some of my correspondents inform me, that fewer of their patients have failed of infection by inoculation since they have been in use to repeat the application of pocky matter some days, than formerly when they applied the matter only the first day.

So soon as inoculation is performed, the patients are generally confined from exposure to much heat or cold, and they are not allowed violent exercise, nor rich strong food or drink.

The fever and eruption of the small-pox of those infected artificially, are between the sixth and fourteenth day after inoculation has been performed.—When these appearances are sooner or later than the days now mentioned, the infection is thought to be from the air, and not by inoculation.

All the practisers of inoculation agree in asserting, that there are much fewer confluent small-pox, and much less danger of the secondary fever in this disease, when communicated by this operation, than when it is owing to the common natural infection.—Some of my correspondents affirm, that when the malignant confluent small-pox were epidemic, and very fatal in their neighbourhood, they became much milder and less dangerous soon after these gentlemen had inoculated a number of children in

that part of the country, with good matter taken from those who had the disease in the most favourable way.

More of the patients who died of inoculation were killed by convulsions, near the time of the eruption of the pimples, or upon their subsiding on the second or third day after their first appearance, and by erysipelatous or rashy eruptions, with spasms when the small-pox were blackening *, than by any other cause.—Some of the inoculated had the same appearances as in the bad confluent natural small-pox;—and a few had other uncommon symptoms, the histories of which I am to give in my answers to some of the other questions.

The general management of the inoculated, after the fever began, was, to give them the antiphlogistic or cooling diet, and plenty of weak antiputrescent drink;—to guard against heat as well as cold;—and to keep both the mind and body as much in a state of rest as could conveniently be done.——In great numbers of these patients no more was necessary: But when the fever was high, or too low;—when the eruptions collapsed, or did not fill in due time, or with right matter;—when convulsions, inflammatory eruptions, &c. supervened;—the practice was varied according to circumstances, of which it would be impertinent in me to give an account to such masters of the science of medicine as I now write to.

After the small-pox blackened, and the patient's strength or other circumstances would allow, repeated purgatives were given, to carry off any remains there might be of the disease.—If any apparent disorder was at this time observed, the proper practice to remove it was employed.

If I have been too prolix or minute in this historical narrative, I flatter myself, that the Learned Delegates will impute this fault to my zeal for their service.

I shall now proceed to the second article of Question I.

With what Success was Inoculation performed?

In

* When the skin of variolous pimples begins to shrivel, and the matter contained in it to change from the white to a darker colour, the small-pox are said here in Scotland to begin their blackening; and they are in a blackening or blackened state till the dry crusts separate from the surface of the body.

In the letters of most of my correspondents, mention is made of some on whom inoculation was performed without the effect of producing small-pox:—Of these the greater number suffered nothing but the little operation;—in a few, the small wound inflamed and suppurated some days.—I cannot specify the number in whom inoculation failed to produce the desired effect, because many of my assistants did not inform me in how many they saw this failure; and I did not think the omission of such consequence as to deserve the trouble of their writing a second letter on that account: but, on the whole, they seem to have been at least as numerous as those in the column of the dead in the answer to Question II.

Though my friends neglected the numbers of those who suffered scarce any inconveniency from the failure of inoculation, yet they are particular as to those who underwent any other trouble from this operation; and these are the following.

In three inoculated, a fever was observed at the common time; but went off without eruption *.

One, whose history shall be afterwards related, had no variolus eruption; but suffered greatly from an abscess in the arm-pit.

One, on the sixth day of inoculation, had erysipelas on the face, which went off without any variolous pustules appearing.

Of twelve infants, inoculated within a fortnight of their birth, not one had the small-pox; but in some of them a rash appeared about the time when the variolous eruption uses to be seen.—Children five months old, inoculated at the same time, and with matter from the same subject, had the small-pox in the regular manner †.

Several who had no small-pox from a first inoculation, had this disease by repeating the operation once or twice.

4 S 2

Some

* In a letter from a gentleman of long practice, it is affirmed, that those who have a fever excited by natural or artificial variolous infection, without eruption, are as little subject ever after to true small-pox as those in whom this disease proceeded in the ordinary form; and that he had frequently foretold this, and was not once disappointed.—I beg other practitioners would inform me what they have observed as to this fact.

† What was the shortest time after birth when the small-pox were produced by inoculation is wished to be known.

Some in whom the inoculation had failed to produce the desired effect, underwent, after some time, the small-pox in the common natural way.

A few in whom the inoculation had been repeated without effect, have now had communication several years with those in the small-pox, without being infected by it.

The success as to life is next to be related, in answer to

Q U E S T I O N II.

Did some of the Inoculated die ?

That several inoculated died, is certain; and of these the greater number lost their lives by that infection; while some who had the operation performed on them, and died soon after, were thought to have been killed, or to have had their danger greatly increased, by other causes.

To state, in an easy view, the proportion of those who died, I have formed, out of my public-spirited correspondents letters, the following table. In the first column of which the names are put of the gentlemen who are my informers.—In the second column are the names of the places where they reside, in and near to which their practice principally is.—The third column contains the numbers of those who recovered from small-pox which they had by inoculation.—And, in the fourth, is the number of all the inoculated who died, without making any allowance for the other causes which were alleged to have brought on the fatal catastrophe.

TABLE

INOCULATION OF THE SMALL-POX IN SCOTLAND. 693

TABLE OF INOCULATION.

<i>Correspondents.</i>	<i>Residence.</i>	<i>Reco- vered</i>	<i>Dead</i>		<i>Correspondents.</i>	<i>Residence.</i>	<i>Reco- vered</i>	<i>Dead</i>
The physicians and } surgeons of	Edinburgh } and Leith.	703	10 = $\frac{1}{71}$		Mr James Oughterson	Brought over,	3751	40
Messrs William Hutchison					Mr Robert Kirkland	Falkirk	38	1
John Cunningham	Dalkeith	52	1		Gogar	-	85	1
Calderwood					Mr Robert Spotswood	Cramond	5	
Mr Thomas Dallas	Musselburgh	14			Dr James Smith	Borrow-	12	
Mr Archibald Scot		12			Messrs Glasford & Clerk	Stounness	5	
Mr John Forrest	Tranent	16	1		Dr John Stedman	Dunferm-	48	
Mr Charles Macky	Ormiston	28			Mr William Gulland	line	5	
Dr James Lundie	Haddington	100	2		Mr William Stenhouse		20	1
Mr James Hamilton	Dunbar	38			Dr Henry Miller	Kirkaldy	42	
Dr William Balderston		29			Dr Thomas Simson	St Andrew's	42	4
Mr James Wood	Berwick	21			Dr George Bethune	Coupar of	11	
Dr John Millar		34	1		Rigg	Fife	5	
Dr Ormiston	Kelfo	6			Robert Menzies		30	2
Mr Thomas Davidson		9			Mr James Paterson	Carpow	4	1
Dr Robert Mercer	Selkirk	24			Dr Robert Wood	-	73	
Mr William Laing		17			Mr Neil Menzies	-	8	1
Mr Thomas Rutherford	Jedburgh	7			Mr Patrick Nisbet	Perth	19	1
Mr William Scott	Hawick	31			Davidson	-	2	
Mr John Dunfe	Langholm	8			Mr Lindesay	Crief	6	
Dr George Grieve	Peebles	2			Mr James Spence	Dunkeld	15	
Dr James Hunter	Moffat	70			Dr Ogilvie	Forfar	30	
Dr Ebenezer Gilchrist	Dumfries	560	9		Mr John Stevenson	Arbroath	30	
Dr Alexander Campbell	Ayr	75	2		Dr John Mudie	Montrose	7	
Dr Jasper Tough	Kilmarnock	24			Dr Aikman		3	
Dr John Cumming	Irvine	260	1		Dr Alexander Rose	-	49	3
Mr Lachlan Campbell	Cambelton	65	1		Dr Thomas Livingstone	-	28	1
Mr James Flint		150	2		Dr Forbes	Aberdeen	10	
Mr Swan	Dumbarton	59			Dr Burnet	-	9	
Mr Alexander Molison	Port Glas-	95	1		Dr Andrew Skene	-	31	
Mr H. Maclean	gow	5	1		Dr David Skene	-	30	
Mr Nathaniel Wilson	Greenock	15			Dr James Saunders	Bamff	210	1
Mr Graham		17			Dr Seton	Frazer-	17	
Mr Gilbert Lauson	Paisley	12	1		Dr Finlay	burgh	5	
Dr John Gordon	-	200			Mr David Brodie	Elgin	2	
Mr John Moore	-	64	2		Mr Forbes	Nairn	8	
Mr Thomas Hamilton	-	50			Dr John Alves	Inverness	25	1
Mr Robert Wallace		32			Mr Alexander Munro	-	10	
Mr Ninian Hill	Glasgow *	50			Mr John Maclean	Sky	188	10
Messrs Maxwell & Parlange	-	60	2		Mr Neil Beton	Dingwall	10	
Mr John Crawford	-	300	1		Mr Hugh Macfarquhar	Tain	23	
Mr James Muir	-	200	2		Dr Alexander Mackenzie	Milnmount	55	
Dr John Cook	Hamilton	13			Mr Alexander Mackenzie	Dornoch	127	1
Mr William Leckie	Broich	16			Dr William Sinclair	Thurso	245	3
Dr Walter Stirling	Stirling	208			Dr Hew Sutherland †	Orkney	60	1
					Mr John Gifford	Shetland	16	
Carried over,		3751	40		Total,		5554	72 = $\frac{1}{78}$

* My ingenious friend Dr Alexander Stevenson physician in Glasgow, to whom I am obliged for collecting the lists and observations sent me from that city, and the towns in its neighbourhood, had always surgeons employed when he attended inoculated patients, who are all in the lists sent by the surgeons, and therefore his name could not be inserted in the table.

† My worthy friend Dr Sutherland unluckily died before I began this inquiry. The number I have put to his name I am certain of by the information received from Mr Mackenzie of Dornoch, who was his assistant when he first began this operation: but in another letter, the authority of which I cannot so much rely on, it is asserted, that Dr Sutherland inoculated 600, of whom only one died; but whether 112, inoculated in the North Isles by Mr Mackenzie, are included in this number, I cannot determine.

Without

Without any regard to the uncertain account of Dr Sutherland's practice, or to the different causes which the practisers of inoculation thought contributed to the death of their patients, it appears from this table, that scarce one of seventy-eight dies of small-pox thus artfully excited; whereas, from Dr Juryn's and Dr Sceleuchzer's accounts of the proportion of deaths to those who recover of small-pox taken by the common natural infection in several parts of England, we see that one of six dies; and of those inoculated in England, during the first eight years after inoculation was practised there, one of fifty died, when no allowance was made for other causes.

These causes ought, however, to be considered, and the cases of such patients to be fairly stated, that every one may judge what allowance is to be made for them in determining the proportion of those who recover from inoculation to those who die of it.—I shall therefore here relate what has been communicated to me by my correspondents concerning this subject, arranging them, according to the causes, into classes; whereof [A] is the bad constitution of the patient, and improper time of inoculation;—[B] is the bad management of the inoculated;—[C] the natural, not the artificial infection, being the cause of death;—[D] other supervening diseases killing the patients.

[A] *Bad constitution and improper time.*

1. A child of a very weak sickly constitution was inoculated contrary to the declared opinion of the ordinary physician of the family, who at the same time consented to the operation being performed on other two children of the same family; who recovered very easily, though the first-mentioned died.

2. A child too lusty, and under fits of teething, was inoculated contrary to the opinion of the operator; and falling into a convulsion two days before the ordinary time of eruption, died in it.

3. 4. Two in such bad states of health, that the inoculators refused for some time to perform, but were at last prevailed on to do it by the earnest solicitation of the parents, who flattered themselves that their childrens constitutions might be mended, as others of their acquaintance had been, are in my column of dead.

One

5. One always very sickly, and subject to frequent rashes and other cutaneous eruptions, which were concealed from the operator, was inoculated, while a very mortal confluent small-pox was very frequent in the neighbourhood, and died.

6. A child under teeth and itch, concealed from the inoculator, died.

7. 8. A child under a severe cold and teething, and another while in a common fever, were inoculated, and died.

9. A child whose head was larger than ordinary, and of a family where eleven of fourteen children had died of diseases in the head, is in the column of the inoculated who died.

[B] *Bad regimen or management.*

10. A child, whose mother was its nurse, became feverish on the third day of eruption, which caused violent anxiety in the mother; a rash, with costive belly, was then observed, and the child died on the second day after it.—At the same time another child, who had a nurse of little anxiety, fevered also on the third day, but recovered well.

11. A very anxious mother kept her child, contrary to the advice of the inoculator, in a very close warm way, from the day of inoculation till it died.

12. An attendant clandestinely gave large quantities of strong food and sweet-meats to an inoculated child, who fevered and died.

13. A nurse of an inoculated child who died, was discovered to have drunk immoderately of malt-liquor during the process of inoculation.

14. One indulged in animal-food and fermented liquors, and who was overheated by running in the open fields some days after being inoculated, is in the column of the dead.

15. The nurse of an inoculated child who died, was suspected to have been tainted with the *lues venerea* by her husband; who was afterwards discovered to have had this disease at the time she was nursing this child.

[C] *Natural infection.*

16. 17. While very bad confluent epidemical small-pox raged, three daughters of parents whose families had suffered greatly by natural small-pox, were inoculated at their intreaty, after being prepared with *Æthiops mineral*,

mineral and some doses of cathartics. The arms of the two eldest, where the incisions were made, never inflamed, nor did the little wounds suppurate. They sickened on the eighth day of inoculation; and soon after the eruption shewed itself of a bad kind, and on the ninth day thereafter they both died.—In the same week twelve other children, who had the small-pox from the common natural infection, died in the same little street.—The third child's arm inflamed, and discharged matter eight days, and then healed.—Upon her two sisters pox being seen of a bad kind, she was removed to a house at a distance from her father's, where she fevered on the twenty-fourth or twenty-fifth day after her inoculation, and had a great number of distinct, but watery small-pox, from which she narrowly escaped with her life.

18. 19. While the epidemic small-pox with petechiæ raged, four children were inoculated, of whom two became sick on the sixth day, with all the symptoms of the then epidemic, and died.—The other two sickened two days later, and had very mild small-pox.

20. A child sickened immediately after inoculation, and variolous pustules appeared on the third day.—On the fourteenth a mortification was seen at the incision in the leg, with swelling and inflammation on all that thigh and leg.—There were afterwards two returns of these symptoms, and erysipelatous swellings appeared in other parts of the body, and at last death put an end to all the troubles.—Another child inoculated with the same pocky matter as was employed to raise the small-pox in the preceding case, fevered at the ordinary time, and recovered, without having any bad symptom.

21. A child sickened the third day after inoculation, and the small-pox were seen on the sixth, of a most virulent kind, which caused death; while another inoculated with the same matter, had the small-pox at the ordinary time, and altogether favourable.

22. 23. While the small-pox were frequent, and of a very bad kind, one inoculated child fevered on the third day, and the pustules appeared on the second day after this; and another fevered on the fifth day after the incision.—The small-pox in both were very confluent; and one of the patients died on the eleventh day after the first appearance of eruption, and the other died on the tenth day after inoculation..

24. One

24. One who had communication with a family where very bad natural small-pox then were, being inoculated, the pustules made their appearance between the third and fourth day after inoculation.—The small-pox were of a very bad kind, and the patient died.

25. Five were inoculated with long-kept matter on the fourteenth day thereafter. One of these fevèred, and in two or three days more the small-pox appeared. This patient did well, and recovered.—Three of the five fevèred six weeks after the inoculation. One of these had numerous but distinct small-pox, and recovered: but the other two had the bad confluent kind; of which one died, and the other was much pitted.—The fifth of the inoculated had no small-pox.

26. A girl inoculated on Monday, sickened on Tuesday, and died on Friday, covered with livid spots, but without any variolous pustules.—Three others of the same family, inoculated at the same time, first sickened on the eighth day.—One of them had purple spots, with the small-pox;—the second had them of a milder kind;—and the third had them in the most favourable way. They all three recovered.

27. The arm of an inoculated child healed soon without inflammation, or any other bad symptom, till after twenty days, when it sickened, and had confluent small-pox, of which it died.—Two brothers of this child inoculated at the same time with it, had the ordinary course of mild small-pox by inoculation, and recovered soon.

[D] *Supervening diseases.*

28. In a child who had been inoculated, two teeth appeared about the time of its death.

29. In a season when erysipelas was very frequent, a child was inoculated for the small-pox. Next day, an erysipelatous swelling was seen on the scarified arm.—The fever and small-pox were mild; but the erysipelas gradually extended itself over the arm and a considerable share of the trunk of the body.—The small-pox being few, distinct, and filled with good matter, blackened on the ninth day after their first appearance; but the erysipelatous œdematodes having continued to extend itself, the patient died on the twelfth day.—Others who were inoculated with mat-

ter taken from the same person, had the small-pox of a good kind, without erysipelas, or any other bad symptom.

30. While erysipelas and a slight kind of the malignant sore throat were frequent, a child being inoculated, was seized with a scarlet eruption, and died.—A sister of this child, who formerly underwent the small-pox, having her ears pierced at this time, was also seized with the scarlet fever.

31. 32. Four children were inoculated at the same time.—On the evening of the day of this operation, an elder sister of theirs, who had formerly the small-pox most successfully by inoculation, shewed some symptoms of the *tussis convulsiva*, (kink or whooping cough). Whenever her being in this disease was ascertained, she was sent from home to a friend's house, where she had this cough so violently, that with difficulty her life was saved.—One of the inoculated had the small-pox regularly, and not above sixty in number, which matured properly; but symptoms of the kink-cough gradually increasing during the progress of the small-pox, it became suffocating at their blackening, and she died soon.—The youngest child inoculated had mild small-pox and cough; but soon after the blackening of the pox an erysipelatous eruption appeared near the incision for inoculation, and then spread over her arm to different parts of the body. This, with the continuing convulsive cough, put an end to life in a few days after the death of the child in the preceding history.

33. On the third day after a girl was inoculated, measles, with their preceding and concomitant symptoms, appeared; and were so violent, that she died on the twelfth day.—Her brother had the small-pox by inoculation in a favourable way, at the same time; but on the sixteenth day, when the small-pox were fully blackened, he was seized with the measles, which were severe but not mortal.

34. 35. 36. Three of the patients whose history is related in my answer to Quest. V. to wit, the one with cramps in her bowels and tumours in her limbs,—the child whose clavicles became carious,—and the one who died scrophulous, being inserted into the column of the dead, notwithstanding its being alleged that the small-pox were not the cause of their deaths, should be added to the cases above related, on which judgement is to be passed by those who consider this subject; and according to
inoculation

inoculation being acquitted of more or fewer deaths laid to its charge, it will appear more or less beneficial.

Thus, if the death of all the thirty-six patients whose cases have been just now mentioned, is attributed to no other cause than inoculation, every seventy-eighth person of those who have the small-pox by inoculation dies of that disease, as you see added to the sums in the table. But if any think the other causes mentioned rather to have caused some or all of these deaths, then such number being subtracted from the sum total of deaths, the proportion changes in favour of inoculation: As, for example, if four are subtracted, the proportion is one of 82; if the subtraction is of 8, the proportion is $\frac{1}{87}$;—if of 12, the proportion is $\frac{1}{93}$;—if of 16, it is $\frac{1}{100}$;—if of 20, it is $\frac{1}{107}$;—if of 24, it is $\frac{1}{116}$;—if of 28, it is $\frac{1}{127}$;—if of 32, it is $\frac{1}{139}$; if all the 36 were admitted to die of other diseases, one of 155 would only have been killed by the small-pox: and in this calculation no regard is had to the 540 or 428 patients, who, besides the 60 entered in Dr Sutherland's name into the table, were said to have been inoculated successfully by him.

Q U E S T I O N III.

Did some who had undergone Inoculation take the natural Small-pox afterwards, and at what time?

It was already observed, that the greater number of those who had the operation of inoculation performed on them without being infected by it, were afterwards subject to small-pox from a second or third inoculation, or by infection in the natural way: but my correspondents almost all agree with me in affirming, that they never saw any attacked by *true* small-pox after they had the *true* kind, whether communicated by art or nature; and I have good information of fresh variolous matter having been applied to the little sores which continued open, and running, after the blackening of the small-pox was complete, without causing new pustules, or any other observable phenomenon.

I have been several times told by parents and relations, that the children then under my care in the *true* small-pox had formerly undergone

that disease : but upon my desiring them to recollect, whether the same individual pimples had, in the former disease, remained turgid till at least the seventh day of their eruption, as they might see the present ones would do ; or whether there was only a succession of pimples, each of which collapsed on the third, fourth, or fifth day after the eruption of each, and by their succession there was an appearance of turgid pimples on some part of the skin during eight, nine, or ten days ; they acknowledged, that each of the pimples in the former disease seemed ripe, and collapsed, before the seventh day ; and thence I concluded that former disease to have been one of the *bastard* kinds of small-pox.

One history was indeed wrote to me, of a child who was said to have died of the natural small-pox a year or two after having this disease by inoculation ; which had induced many to refuse inoculation to their children or friends.—Luckily the names of the parents were mentioned, which gave me the opportunity of making a strict inquiry into this case ; and now, from undoubted good evidence in my possession, I can relate it.—In October this child had the incision made, and pocky matter applied to the little wound in its arm ; but neither fever, inflammation, small-pox, or any other disorder, were produced, and the incision healed in a few days :—the parents therefore resolved to have the child inoculated in the mild warmth of the following spring ; but, unfortunately, in the month of March, the child was attacked and killed by the small-pox caught by the common natural infection.—Other children of the same parents have since had the inoculated small-pox in a very favourable way, and have frequently since that been exposed to infection without any sort of disorder.

Q U E S T I O N IV.

Do you know that other Diseases have been ingrafted with the Small-pox by Inoculation ?

I never saw other diseases communicated by inoculation ; and my correspondents agree with me in this negative ; nay, one of them informs me, that variolous matter taken from a child in the natural small-pox,
who

who at the same time had the whooping or croup cough, was employed for inoculating another child, who thereby had the small-pox, but suffered no *tussis convulsiva*.

I must, however, here relate a history sent to me, which is thought to infer the ingrafting other diseases by inoculation for the small pox.—A physician who had a number of patients in an epidemical *raſh*, caused his own child to be inoculated; and being attentive to its welfare, visited it often.—On the eighth day after inoculation, the *raſh* appeared on the child; but going soon off, the small-pox rose, and were of a very good kind.—Matter taken from this child's pox was employed to inoculate other children; who had the *raſh* and the small-pox in the same way as the former one.—The matter taken from these had the same effect on another set of children:—and these, I am told, but not on so good authority, infected a third set in the like manner.

As the first child mentioned in this history had the *raſh* from its father, or the epidemic constitution of the air, many think, that the *raſh* in the other children was rather owing to contagion communicated in some such way, than to the variolous matter with which they were inoculated.

Q U E S T I O N V.

Whether did many, after Inoculation, labour under various Diseases which seemed to be owing to this operation? and whether did this happen more frequently or seldomer than from the natural small-pox?

The sides of the little incision made for inoculation generally swell, inflame, and suppurate, and a discharge of matter continues from them till the small-pox are gone.

These little sores have sometimes continued running weeks or months after the small-pox.

In some the swelling of the arm has been considerable, and the glands of the arm-pit have swelled and become hard; but both these symptoms generally disappeared as the small-pox ripened.—In a few the axillary glands suppurated; but in a mild way, and soon healed.—One history

story of a suppuration in this part, which I formerly referred to, seems worthy to be related. An inoculated child was seized with a fever on the fourteenth day after inoculation; on the seventeenth, little pimply spots were seen, but disappeared next day, and no pustules could afterwards be observed. The child continued very feverish and in pain during a month: at the end of which a large tumour was discovered in the arm-pit; which being fully suppured, was opened next day, and then all the bad symptoms ceased.—This child has not yet had *true* small-pox, though, during near three years since the boil in the arm-pit, it has been several times in the way of infection; but it has suffered the *bastard* small-pox, with a smart fever before their eruption.

Two histories are sent me of children who, in the fever before the eruption of inoculated small-pox, had such coldness in their feet and legs, as scarce could be removed by any applications, but went off as the pimples appeared.

The convulsions about the time of the eruption and subsiding of the inoculated small-pox formerly mentioned, is the most frequent bad symptom in this disease; and by them more of those in the column of dead lost their lives than by any other cause.—On the other hand, several of my correspondents remark, that those who survive the convulsions at the eruption of the small-pox, brought on by nature, or by art, have generally few and very favourable small-pox.—An exception to this is wrote me of a young lady, who, after convulsions, had a very bad confluent small-pox; at the *blackening* of which the convulsions returned, and killed her.—By the shock of such convulsions from small-pox, another young lady was made incapable of speaking or walking; and now, after several years, she has not the right use of the members affected.

Two of the inoculated had tubercles, like those occasioned by the bites of bugs, some days before the eruption of the small-pox; but they went off as the pocky pimples advanced.

Rash, and suppurating tubercles, in different parts of the body, have been observed after the artificial small-pox blackened; and some of my correspondents think that this oftener happens in such as had very few pustules than in others.—These symptoms have generally been easily removed. But there are two examples sent me of suppurations which were tedious

tedious in the cure.—One of these patients had a nurse subject to inflammatory eruptions, and who, in the time of the child's inoculation, had fores on her neck and upper part of her breast, which she artfully kept long concealed.

One inoculated patient, subject formerly to inflamed eyes, had them worse after the artificial small-pox.

Some alleged, that the misfortunes in the following case were owing to inoculated small-pox; others attribute them to a different cause. That you may be able to determine this question, I shall give the history of the patient, as it is communicated to me. Six of one family were inoculated, and all of them had a very favourable good small-pox, and recovered so well as to be let go abroad to their childish plays. About three weeks after the blackening of these pox, three of the inoculated, and several others of the family who had the small-pox several years before, were seized with an eruptive fever, which was then epidemical in the neighbourhood. The fever was generally mild, scarcely confining any to bed: but was rather more severe to a girl, the eldest of the inoculated, than to the others; and the eruptions, which had something of the measles appearance, going off suddenly from her skin, she was seized with spasms in her bowels, and trembling of her whole body, which went off, and returned periodically, with violent pain in the toes of the left foot, and at last ended in a paralytic affection and mortification of that leg. She struggled more than three months under a train of misfortunes, and then died. She is in my column of dead; but is one of the three last-mentioned exceptions to the number in that column.

One had a slow swelling on the ankle, which was some months in healing.

One was subject to glandular swellings and excoriations of the feet, after having undergone the inoculated small-pox.

A child of parents of a scorbutic habit, whose hands were generally hard and scaly, with chops in them, being inoculated, had about sixty small-pox, with little or no uneasiness till the fifth day of the eruption; when, being carried through the house, and to the open air at the door of it, she was seized with a violent fever, which continued three weeks. In the course of this fever, several abscesses formed, containing a sanious matter;

matter; and in two of these the clavicles seemed to be carious. By the discharge from these sores, she sunk and died. This is another exception to the column of the dead.

A gentleman told me, that he had sometimes suspected *scrophula*, king's-evil, to have been a consequence of inoculation: but being asked what the constitution of the parents of the children thus affected were, he said some of them had been scrophulous; and the others, whose history he had no such access to know, were of the make and countenance which I described those subject to *scrophula* generally to have.

One of my correspondents writes me, that a scrophulous boy, whom he unwillingly inoculated at the earnest solicitation of the parents, has had a better constitution and fewer running sores, since he recovered from the artificial small-pox, than he had before that disease.

Several of my correspondents assure me, that not a few children, who were delicate and unhealthy, had their constitutions greatly mended, after undergoing the inoculated small-pox; and that the knowledge of this was the motive inducing several parents to insist on the inoculation of children whom the inoculators did not think proper patients for undergoing such an operation.

An ambiguous case, or at least about which there have been different opinions, I must refer to your judgment. A girl, four years old, the child of sound parents, being inoculated, fevered at the ordinary time, and continued in the fever three days; during which the lips of the wound swelled, inflamed, and discharged fetid ichor. The fever then abating, the little sore suppurated plentifully, several thick sloughs casting off, by which the orifice was considerably enlarged, and some few pustules appeared round the edges of it; but whether these were owing to local infection, or to a sticking-plaster applied there, the observer could not say. The sore continued to discharge matter plentifully two months, and then gradually healed. The child remained in perfect health fifteen months, when some swellings of the scrophulous kind appeared. Several months after she became hydrocephalous, and died. She is also in the column of the dead; but is the last of the exceptions referred to from the answer to this Question V.

These histories of all who were suspected to have diseases in consequence

quence of inoculation, that have come to my knowledge, are the only answer I can give to the first part of your fifth Question, viz. *Whether did many, after inoculation, labour under various diseases which seemed to be owing to inoculation?* But as to the second part of that question, *Whether these diseases happened more frequently or seldomer after inoculation than from the natural small-pox?* my correspondents seem all to agree, that there are not near so numerous or various bad consequences after inoculation, as after the small-pox by natural infection; and when I assure you, that I have been so fortunate, or perhaps timorously cautious, that not one of those whose inoculation I advised had a dangerous symptom during the disease, nor a bad consequence from it, you will conclude that I must be of the same opinion with them.

Having thus answered the judicious questions of the Learned Delegates in the best manner I could, I shall conclude this long epistle with my most earnest and sincere wishes, that the present inquiry may be as beneficial to mankind as the Delegates intend it. I am,

Most Worthy Dean,

Your and their most obedient humble Servant,

EDINBURGH, }
June 27. 1764. }

ALEX. MONRO.

De CUTICULA HUMANA.

APUD omnes in confesso est, nullo expressiore, simulque ad assensum extorquendum efficaciore argumento, evinci summi Numinis existentiam, quam eo quod ex mundi rerumque quæ in eo sunt contemplatione nobis subministratur: Qui enim tam elegantem machinam excogitarit, infinita sapientia; et qui excogitatam perfecerit, immensa item potentia præditum esse necesse est. Data mihi provincia est, ut ex tam vasta a ter maximo hoc Conditore factorum operum copia, perexiguæ cujusdam partis fabricam explicare adniterer. Id scilicet muneris mihi impositum est, ut corporum animatorum, præsertim vero humani, structuram et constitutionem pervestigarem, ejusque notitiam aliis pro virili impertirem. Fieri autem omnino non potest, quin qui hanc scientiam vel a limine salutarit, alacri, lubentique animo agnoscat, non minus vere quam eleganter a psalmographo dictum, Nos verendum, atque mirificum in modum factos esse. Nisi enim omni prorsus cogitatione simus destituti, non possumus non corporum nostrorum artificium admirari, simulque gratissimo sensu affici, tantæ illius solertiæ ac concinnitatis, qua universa ipsorum organa ad varias quibus opus est vitæ actiones peragendas sunt efformata: idque ita demum ut in singularum partium structura dispositione et nexu, nostræ voluptatis, incolumitatis, conservationisque interea ratio habeatur. Quod ad illustrandam summi Creatoris bonitatem, sapientiam, potentiamque, et ad grati animi nostri atque ab eo dependentiæ sensum nobis inculcandum exemplum in præsentia mihi constitui, est Cuticula Humana: Argumentum quidem a diligentibus etiam machinæ animalis indagatoribus, levi brachio tractatum, a vulgo autem parvi aut nihili pensum, ne dicam contemptui habitum. Quo autem

hæc

hæc res ab aliis minus curata aut æstimata fuerit, eo magis mihi animus additus est, ut eam dissertationis meæ materiam seligerem; præsertim cum quæ inde generatim sum ducturus confectaria (quem præcipuum dixi a me finem propositum) plus firmitatis habitura videri queant, si ex re minus favorabili, justo ratiocinio, sint collecta. Haud parum etiam, ut id argumentum mihi pertractandum desumerem, apud me valuit, quod ea pars corporis nostri sit omnibus notissima, et quum extimum sit illius operimentum, satis aptus est carcer ex quo prælectionum curriculum inchoans dimittatur.

Est autem (ut ad rem aggrediar) cuticula, tenuis illa cutis per universam corporum nostrorum superficiem expansa, quæque toties in vesiculam aquosa liquore refertam attollitur. Latini *cuticulam*, five parvam cutem, vocitant: a Græcis *epidermis*, five cutis tegumentum, nuncupatur: unde et Galli, nostrique Britanni, Græco vocabulo vernacule reddito, *surpeau*, et *scarf-skin*, eam appellant.

Cuticulæ color, nigerrimis etiam Ethiopibus æque ac formosissimis in Europa natis hominibus, albus est. Hujus rei satis idoneum indicium attulere rei anatomicæ cultores, qui extimum hocce cutis integumentum, tam in hybridis quam in veris Æthiopibus, ab aliis ei contiguis partibus separando, eam quam intuentibus præ se fert cuticula nigredinem, a translucente, quam ea operit, substantia tractam esse; ea autem detracta, albidum protinus colorem se manifeste ostendere deprehenderunt. Hujus rei ratio postea reddetur.

Cuticula flexilis est, ad formam figuramque partium quibus connexa est sese accommodans, viribusque rerum sibi applicatorum ita cedens, ut neque partium quas tegit motus impediatur, neque impressiones partibus hisce ab aliis corporibus impactæ prohibeantur. Vix altera manus alteri imponi potest, quin hujus flexilitatis signa se nobis videnda exhibeant.

Cum vis quælibet distendens huic vivi hominis membranæ sensim adhibetur, natura eam extensili nullis limitibus circumscripta, absque partium dilaceratione, pollere compertum est. Rei fidem firmant, commodaque inde orientia ostendunt lactantium fæminarum ubera, pregnantiumque uteri, sæpenumero etiam monstrosi illi morbidique tumores, qui per totum corpus aut partem ejus aliquam paulatim induci solent.

Quin et epidermis haud modicam extensionem etiam subito illatam

pati potest, quanta scilicet ad necessarias vitæ functiones obeundas requiritur. Quod si subita hæc extensio ultra eum quo tunc gaudet tonum cuticulam dilatet, ipsius non minus atque aliæ corporis partes a se mutuo segregantur ac disrumpuntur.

Ut cuticula vi extensili, ita et contractili imbuta est. Postquam enim ea magnopere tensa est, ad pristinam suam dimensionem una cum cute se restituit: unde et ejus contractionis quantitas dignosci potest, adeo ut si cutis lævis ac plana haud evadat, cuticula rugis obsita permaneat. Cæterum hujus quam in corporibus deprehendimus flexilitatis, extensilitatis et contractilitatis causas physicis rerumque naturalium indagatoribus exponendas relinquentes, non possumus tamen hic non animadvertere quam apte, sapienterque hæ huic membranæ inditæ sunt proprietates, quæ eam ad partes quibus tot et tam varii motus peragendi sunt, protegendas, ac porro ad cedendum seque deinde restituendum, etiam in casibus morbidis, perinde ac in communibus vitæ functionibus, habilem atque opportunam præstent.

De contractili autem cuticulæ indole, dignum in primis est observatu, eam cuticula corpori detracta, etiam post extensionem quamdiu se cumque ea extensio continuat, proprietatem retineri: cum pleræque aliæ corporum nostrorum partes, si extensæ donec arescant ferventur, omni tum se restituendi potestate orbæ fiant. Hujus rei periculum ipse feci: detractam enim cuticulæ partem, quæ in tabula extensâ per decennium servabatur, protinus rugosam fieri, seque contrahere deprehendi.

Si partes subter cuticulam illæfæ custodiantur, discindi aut alio quovis modo destrui potest ipsa cuticula absque ullo molestiæ sensu, unde haud immerito cuticula sentiendi exfors perhibetur. Huic autem hujusce membranæ insensibilitati maxima vitæ nostræ felicitas accepta referenda est. Corpora nostra nimirum innumerarum aliarum rerum vim excipere, ab iisque duriter premi necesse est. Id autem si parti tactus sensili accideret, fieri non posset quin in perpetuo cruciatu angoreque vitam ageremus. Hi certe quibus vel medicaminibus vel utionibus cuticula est derepta, non sine affectu commemorare possunt, quanta commoda, ex spreta hac membrana prius, reportarint.

Ex ea qua gaudemus, dum cuticula integra est et incolumis, accurata tactus sensatione, cum eo quem illa dirempta perpetimur dolore, comparata,

parata, ipsaque experientia docemur, unum hujus cuticulæ usum esse, ut idoneum inde medium subministretur, per quod organa nostra tactus sensui inservientia eo quo par est modo ab sibi abjectis afficiantur; ita, sciz. ne sensus nimium hebes sit, nosque adeo ad judicium de illis recte ferendum inhabiles reddat; neque e contrario nimis sit acutus, qui propterea unam universæ molestam ideam excitet, quem dolorem nominamus, in quo variæ rerum tangibilium formæ, quas alias ab aliis distinguere oportebat, in unum confusæ, deperditæ atque absorptæ sunt.

Quantum in præsens recordari possum, ex omnibus corporis partibus cuticula corruptioni minime obnoxia est. Nihil utique, ignem si excipias, novi, a quo dissolutio aut interitus ei arcessatur. Aqua, oleum, sales varii, spiritus, substantiæ etiam maxime causticæ et erodentes, a cute eam dirimere quidem valent; at integra interim atque illibata manet ejus textura, ac nisi vis mechanica etiam adhibeatur, ne vel illa partium ipsius a se mutuo dissociatio consequetur. Oleum vitrioli, lapidem septicum, aut si quid aliud est rebus animatis magis exitiabile quis admoveat, periculoque factò, quod a me dictum est verum comperiet. Dicat chirurgus quispiam, an cuticulam quavis undecunque collecta puris materie, qualisque alias solidissima corporis ossa cariota sit redditura, erosam unquam sit conspicatus. Quæ ei subjecta est materiæ pondus et extensio eam dilaniare potest, at ejus acrimonia illam erodere non potest. In violentissima gangræna, et universarum quas in vivo homine tegit partium sphacelo, et in supremo corrupti cadaveris statu, non alia ratione dissolvitur, corrumpitur aut immutatur cuticula, quam qua simplicissima quacunque illius a cute separatione id efficeretur.

Jam igitur mecum reputate, auditores spectatissimi, quanta vel ex hac una cuticulæ proprietate commoda hauriamus. Perpetuo nobis hæc undique circumfusa est atmosphæra, in qua infinitæ pene diverforum corporum, omnia corrumpentes, particulæ innatant. Lignum, ferrum, saxa durissima, aëri exposita, consumuntur: corporum autem nostrorum superficies ab eo non afficitur. Nollite vero existimare id a jugi ulla partium cuticulæ renovatione proficisci. Exponentur simili quo cuticula modo aliæ corporis partes in quibus manifesta est hæc renovatio, effectusque multum diversos consequi experiemur. Cuti etenim crusta vel cortex obducitur, quam ab ea separari vel decidere oportet. Vulneris aëri exposita
superficie

superficies putredinem contrahit, quæ nulla arte sanari potest, nisi eam superveniens suppuratio tollat. Ligamenta, cartilagines, imo et ossa solidissima denudata, ærrique objecta, putrida evadunt. Sola igitur est corruptionis expers cuticulæ natura, quæ nos ab omnibus malis quæ ær in quo vivimus et movemus nobis adferret, a cunctisque calamitatibus quas (id quod necesse est fieri) tot aliæ substantiæ nostrorum corporum superficiei quotidie applicatæ generarent, incolumes præstat.

Quamvis autem cuticula dissolutionis aut corruptionis vix sit capax, violenta tamen frictio, partium cohærentiam dirumpendo, structuram illius diruere potest. Quod iis quotidie evenire videmus qui tibias manusve lapidibus vel aspera arena destingunt. Cum vero non adeo prorsus violenta sit frictio, sed ejusmodi duntaxat quæ partes e cuticula contactas fortiter vellicare et proritare valeat, ab iis se partibus cuticulas sejungit, atque in vesiculas aquoso liquore refertas intumescit: quod probe nec sine suo damno sentiunt ii, qui labore haud assueti opificum instrumentis utendis manus admovent. Omnes fere cujuscunque generis substantiæ, veluti æstus, acres sales, spiritus, olea, &c. quæ cuticulæ applicatæ similem in cute proritationem efficiunt, similem, cuticulam in pustulas inflandi, effectum fortiuntur. Hac quam nobis præbent ejusmodi pustulæ utilitate haud satis animadversa, ad nostri corporis fabricam vitii insimulandam, proclives sumus, eo nimirum quod hunc in modum cuticula extumescat. Quod nisi cuticula talibus ex causis non extumesceret, multo graviores nobis patiendæ essent injuriæ. Absque enim harum pustularum interventu, dura illa ferramenta dolorem longe majorem nobis accirent, violentamque ac diuturnam in partibus cuticulæ subjectis inflammationem excitarent. At noxii aliarum proritantium substantiarum effectus, his quasi umbonibus oppositis a cætero corpore defenduntur et propulsantur. Quocirca optima cum ratione existimandum est, hanc epidermidis proprietatem bene prudenterque inditam, nostræque incolumitati ac saluti tuendæ comparatam esse.

Cum cuticula a cute separatur, cito ea renascitur, sive alia cuticula, omnibus quæ priori inerant qualitatibus imbuta, eopse in loco efformatur. Ea nimirum est benignissimi Conditoris cura et providentia, quæ cutem, cujus sensus acutissimus est, nudam atque integumento vacuam, atque adeo injuriis doloribusque opportunam, non passâ est remanere. Cum autem cutis etiam abrepta est, et alba illa rigida, sensuque orba substantia, quam

quam *cicatricem* appellamus formam accipit, nulla quæ eam operiat cuticula (utpote cujus tum nulla utilitas) una effingitur. Extrema quidem cicatricis facies insensibili aliquatenus et incorrupta cuticulæ natura, sed longe minore gradu atque ipsa cuticula gaudet. Atque hinc est, quod truncorum post amputationem extrema, omnesque aliæ cicatrices, frictionibus, offensionibusque expositæ, ad plagas, dolores, ulceraque suscipienda propensiores sint, quam nativa corporis, cuticula contacta, superficies. Cum igitur cuticulam cute salva remanente semper redintegrari, ea vero deperdita nunquam refici conspiciamus, fidenter nobis colligere licet cuticulæ formationem a cute pendere, hancque illius parentem causamque plane necessariam esse.

Superficiem nostri corporis claro luce intuentibus ingens se ostendit numerus pororum, per quos tenuis ac limpidus liquor se perpetuo emittit; ex communi autem experimento, quo substantias cuticulæ applicatas in massam sanguinis penetrare comperimus, constare videtur, alia esse orificia tenues itidem exilesque particulas recipientia. Etenim si ad perennem illum ex iis quæ supra memoravi orificiis scaturientem rivum animum attendamus, neutiquam existimandum est, particulas extrinsecus advenientes adversus hunc rivum introrumpere posse.

De his orificiis ita ut plurimum loquuntur rei anatomicæ cultores, quasi ea nihil aliud essent præterquam simplices in cuticula pori per quos liquores, in ejus superficiem projecti, permeant, eodem nimirum pacto quo aqua linteola superfusa filorum interstitia pervadit. At una et altera satis vulgari simpliceque observatione, rem ita se habere non posse, perspicuum efficitur. Ac, imo, varias novimus substantias, quales sunt viscida balsama, oleaque, quæ eos quos in cuticula aspicimus poros obturare queant. Quod si vera esset hæc de poris doctrina, admotis viscidis hisce substantiis cuticula a liquoribus subtus effusis in bullam attolleretur; at innumeris documentis cognitum habemus nullas ejusmodi bullas attolli, ac proinde qui per cuticulam emittuntur liquores, neutiquam subter eam prius effusos esse. 2do, Cum cuticula in vesiculas attollitur, siquidem quod hi volunt verum esset, necessario per hos poros liquor transfret. At haud paulo secus sese res habet, nisi enim liquoris pondus aut extensio, aut vis externa adhibita cuticulæ partes dilanient, nulla ei elabendi facultas permittitur. Quapropter certo statuendum orificia ea per quæ liquores cuticulam

cuticulam altrinsecus pervadunt, canalium esse ab interioribus partibus continuatarum extremitates: qui canales diffracti liquores suos inter cuticulam partesque ab ea tectas effundunt: et quum cuticula naturam extensilem sit adepta, eam oportet in bullas attolli, e quibus nequeat evadere liquor, eo quod cum reliquæ vasorum cuticulæ adhærentes tenuibus admodum orificiis, lateribusque perquam flexilibus gaudeant, a liquoris vasis contenti pressione vasorum potius latera in se mutuo collapsura sint, quam pendula ipsorum orificia ingressurus sit liquor.

Lewenhoekius, calculo eo de re inito, in cuticulæ spatio non ampliore quam quod ab uno arenæ granulo tegi possit, 125,000 orificiorum (quod omnem pene fidem superat) numeravit. An satis accurate nec ne vir ille celeberrimus rationes suas subduxerit, ad institutum nostrum parum interest. Utcunque enim se res habeat, fat certe nobis suffecerit, ut inde commonstretur, quam oppido exiles, et proinde summo artificio elaboratos hos canales, quorum ea sunt orificia, esse oporteat. Et quidem tam exquisita est eorum fabrica, ut non nisi difficillime oculis eos subicere valeamus, idque post quam possumus maximam in cuticula a cute separanda cautionem adhibitam, præeunte etiam tegumentorum corporis idoneo et permodico putrefactionis gradu, aut per lenem humidumque calorem facta præparatione, quæ cuticulam paulum laxare, non autem a cute eam penitus dirimere debeat. Hac demum ratione, ea vascula nullam aliam præterquam candidorum summeque exilium ingenti numero florum, ægre aliorum ab aliis internoscendorum, speciem exhibent.

Jam vero conferamus horum canalium, per quos præcipue si non unicè cuticula cuti adhærescit, exquisitam ac tenellam fabricam, cum effectibus quos in vasa nostra, ea contrahendo arctandoque, edit irritatio; aut cum corrumpentium nostrorum liquorum erosione; aut denique cum ea quæ frictioni adest extendendi lacerandique potentia, non erit cur admiremur, quod hi canales disrumpantur, et in violentis cutis inflammationibus, re aliqua duriter eam morficante vel irritante admota, accedenteque exiguo putrefactionis gradu, liquores effundant; et ut rem paucis absolvam, quod pustulæ illæ, in quas tot variis ex causis cuticula attollitur, tam crebro se conspiciendas exhibeant.

Quum ea tantum vasa cujusque partis propria anatomici appellant, quæ ramos in ea distribuunt, fluidaque in illius substantiam ad ipsam ibi augendam,

augendam, nutriendamve permanfura, devehere videntur, hi quos descripsi canales cuticulæ *vasa* vocitari nequeunt; atque haud scio an microscopiorum vel injectionum ope ulla cuticulæ humanæ propria vasa unquam in conspectum sint producta. Quin contra credibile videtur vasa ejusmodi oculis cerni non posse. Cum enim nulla alia esse queant, præterquam tunicarum horum quos dixi tenuium canalium vasa; iique canales non ampliores sint quam ut aquam, oleum terebinthinæ purissimum, aut aliud id genus tenue fluidum, per se idque difficiliter admodum percolari patiantur, liquoribus colore aliquo tinctis omnino exclusis; neutiquam expectandum est, multo tenuiora suarum tunicarum vasa particulas recipere posse, quæ lucis radios ea vi, ut se nobis conspicuos sistant, reflectere queant.—Non me latet a quibusdam proditum, vasa in elephanti cuticula, rubrum sanguinem continentia aspecta fuisse. Sed in materia adeo incommoda, verbisque tam generalibus facta est narratio, ut ei non plus fere fidei sit adjungendum, quam ei quod ab aliis nonnullis affirmatur, qui in humanæ cuticulæ vasa injectiones se facere posse perhibuerunt. Sed neque eorum quos descripsi canalium cuticulam penetrantium magnitudo amplis illis quæ in cuticula sunt vasis hilum plus in elephantino quam in humano corpore respondet, utpote quod liquoribus suis per ipsius cuticulam perpetuo emanantibus non irroretur hujusce animalis superficies.

Cæterum ex exilitate quæ cuticulæ humanæ insunt vasorum, tam eorum quæ, si qua habet, ei propria sunt, quam illorum quæ solum eam perforant, quibusque pellucidos tantum liquores admittunt, clare intelligimus quamobrem fiat, ut Maurorum juxta ac Europæorum cuticula candidum colorem sit nacta. Cum porro consideramus quantillam eorum etiam subtilium ac pellucidorum fluidorum portionem cuticulæ compositionem ingredi oporteat, quodque perforantes canales in externa superficie patulas habeant extremitates, per quas tenues liquores effluant, et cum illi disrupti sunt, se etiam in cutis superficiem exinanire queant; quod vasa dein propria si quæ sunt, adeo compressioni rarefactionique sint exposita, ut ea contrahi si non solida fieri necesse sit: hæc, inquam, cum consideramus, haud prorsus ratione absonum videri forsân possit, ut existimemus hunc fluidorum defectum unam ex causis esse, cur cuticula minus quam aliae corporis partes corruptioni sit obnoxia.

Non magis nobis in promptu est nervos ad cuticulam pertinentes vestigiis persequi, quam proprias ipsius arterias et venas acie cernere. Ex iis autem quæ de illius insensibilitate supra diximus, perspicuum est, aut nullos ei nervos esse, aut, ab rigido siccoque ad quem redacti sunt statu, eos ad objectorum imagines menti exhibendas prorsus inhabiles reddi.

Nullus est, quod novimus corporis nostri liquor, qui cum in vaporem est solutus, vel tenuiores ejus partes a cæteris sunt secretæ, vel etiam cum per aliquod tempus in quavis substantia defederit, non aliquam post se faciem aut maculam relinquit: unde nobis colligere fas fuerit, liquores qui canales cuticulam perforantes perpetuo transeunt, quasdam etiam in ejus superficie particulas superstites relinquere. Magis autem persuasum habemus id plerumque evenire, cum manifestas pelliculas a reliquiis horum liquorum crebro formatas conspiciamus. Unius vero ex proprietatibus quæ has fluidorum reliquias comitantur, se prodit indicium, cum observamus, affusis per diutinum tempus in cuticulam liquoribus aquosis, præsertim falsuginosis, aut acrem saponaceamque indolem nonnihil participantibus, cutem tam facile irritari. Hinc est quod lacrymantibus genæ rubræ evadant, doleant et turgescant; quod infantium inguinibus nati- busque urina sua cutem deterat, &c. Hæc autem vix alia ex causa proficisci queant, quam quod liquores illi linimentum a liquoribus cutaneis relictum dissolvant et abstergeant. Id ulterius ex eo confirmatur, quod ubi solito magis adest cutis amittendæ periculum, ut in palpebris, papillis, &c. naturali illic linimento cuticulam larga copia instructam reperiamus: atque ex eo etiam, quod lenia, unctuosa, mucaginosaque medicamenta naturalis illius linimenti locum optime supplere, aptissimeque ad hæc a detrita cute data incommoda vel præcavenda vel resarcienda adhiberi sentiamus. Annon hoc linimentum plurimum præsidii conferre possit, ne cuticula depereat, neque cutis a variis particulis acris in atmosphæra fluitantibus, aut aliarum superficiæ nostri corporis adnotarum substantiarum contactu nimis inclementer accipiat? Nonne et hoc linimentum panniculi ope defricando efficitur, ut omnia medicamenta acria, præeunte hac in locis quibus adhibenda sunt fricitione, fortius quam ea omissa vim suam exerant? Poteritne etiam fieri ut acetum, utpote liquor acer ac salinosus linimentum dissolvens abstergensque, cantharidum po-
tentiam,

tentiam, hac potius quam ulla alia quæ ei assignari potest qualitate promoveat ?

Extensam aliquam cuticulæ particulam vel nudo vel perspicillis adjuto oculo intuenti, ea tanquam uniformis membrana apparet, rhomboidicam, quadratam, vel aliter figuratam partium subtus positarum speciem referens. In iis autem corporis partibus, quæ adversus frictionem munitæ, vel ei parum expositæ sunt, ut in capite sub capillorum radicibus, inter digitos pedum, &c. et juxta cicatricum cute deperdita latera, furfuraceam invenimus substantiam ex plurimis squamis conflata, perfrictaque panniculo alia quavis in superficie corporis parte, panniculum illum substantiis squamularum instar coöpertum reperiimus. Ex qua rerum facie, atque ex ea quæ illam inter externaque plurimorum piscium, anguium, ac nonnullorum etiam quadrupedum, similitudine intercedit, a plerisque concluditur, cuticulam humanam ex innumeris itidem squamis, aliis alias extimo suo limbo supertegentibus, esse compositam. Utcunque tamen cohibere me nequeo, quin existimem non tantum huic argumento, quantum vulgo creditur, roboris inesse. Squamæ enim sub capillorum radicibus interque pedum digitos repertæ, nihil aliud forte sunt quam lemæ ex viscosis linimenti particulis, ibidem ubere copia promanantis, conflatæ. Quæ autem circa cicatricum margines visuntur, in earum autem medio deficiunt squamæ, confici possunt ex liquoribus per cuticulæ cicatricem ambientis poros destillantibus, qui a cicatrice ipsa non suppeditantur; communeque illud linimentum quo in exilium fuorum pororum interstitiis cuticula obtegitur id esse potest quod panniculo detersum est. Ne tamen mera possibilitate inniti videar, observare licet arefactam oculorum saniem, narium mucum, aurium ceram, præputii liquorem, &c. eandem sæpe squamosam imaginem repræsentare. Huc adde, quod quandocunque aquosorum liquorum affusione, vel partium frictione, linimentum in cuticulæ superficie areferi non permittitur, veluti in interiore palpebræ vel oris latere, &c. nihil quidquam squamis simile animadvertere est.

Quod a squamis piscium ad squamas in humana cuticula constituendas desumitur argumentum, parum utique ponderis habet. Nam præterquam quod iniquum sit statuere unius cujusvis speciei vel generis animalis structuram in aliis omnibus locum obtinere, multi pisces sunt, et ex

his etiam ii in quibus corporum tegumenta humani speciem præ se maxime ferunt, qui squamosi esse non dicuntur. Quin et in illis qui squamis operiuntur, nonnullæ partes cuticulæ sunt, ea, v. g. quæ oculos tegit, in quibus nullæ squamæ conspiciendæ sunt. Quod si analogia in his locis pateret, expectandum itidem foret, ut humanarum squamarum magnitudinem formamque, certa lege quemadmodum in piscium genere, dispositam invenimus, quod acerrimi humanarum squamarum assertores nulli affirmaverint. Quoniam igitur nullo satis firmo fundamento squamosa hæc cuticulæ humanæ textura subnixa est, mihi animus inclinatur, ut eam potius ream nihil aliud esse præterquam vasorum supra memoratorum extremitates sibi met arctissime conjunctas, et in unam expansam membranam coagmentatas; furfuracea autem illa corpora, quæ ab ea decidunt vel defricantur, adventitia, non tamen inutilia, accessoria a liquoribus illuc formata, minime vero cuticulæ propria esse, ejusque partes constituere.

Si hoc pacto fabricatam cuticulam agnoscamus, multo nobis proclivius erit rationes reddere, de perspirationis, modicæ frictionis ope, incremento; de pustularum natura et ortu; de cuticulæ, postquam ea sublata est, redintegratione; de jugi illa quæ in cutis superficie, irritantibus vel erodentibus rebus continenter adhibitis, servari queat liquorum effusione; multisque aliis ejusmodi phænomenis, quam communi illa squamarum doctrina fieri possit. Quo majorem doctrinæ, quam sustinere conatus sum, fidem conciliem, phænomenorum statim memoratorum raptim rationes percurrere liceat. Frictione augetur perspiratio, illa quippe vasorum extrema a viscidis quibus illigata sunt liquoribus exsolventur.—— Eorundem vasorum, dum cutem inter cuticulamque transeunt, disruptionem, sive a violenta nimis frictione, sive a convulsiva, quam in ipsis vel in cute concitat irritatio, contractione factam, consequitur effusio liquorum, qui cum nullos poros squamarumve interstitia, per quæ ipsis transeundum sit, habeant, cuticulam a cute attollent, pustulæque aut vesiculæ efformantur. Disruptorum horum vasorum, nisi quod impedimentum injiciatur, extrema se exporrigent, fibrasque suas in mutuum occursum extendent, decrefcentibus interea ipsorum cavitatibus, fibrisque suis arefcentibus firmioribusque evadentibus, redintegratur cuticula. Huic fibrarum extensioni obstat erosio, earumque in unum coalitionem prohibet,

prohibet, continenter igitur adhibitis erodentibus, extrema vaforum irritata, lacerata, dilatata, jugi fluore effundunt liquores.

Quæ hætenus a me de cuticula sunt dicta ei in universum sive omni ejus parte conveniunt. Animadvertendum tamen est cuticulam naturæ suæ, etiamque si nulla causa externa interveniat, multum diversæ in diversis corporis partibus crassitie esse, ac pro majore minoreve ipsius tenuitate vel spissitudine flexiliorem eam rigidioremve fieri. In labiis quidem admodum tenuis est, in extremis digitis majorem paulo et mediam quasi nacta est crassitiem, in pedum vero plantis multo adhuc crassior est: pro modo nempe officiorum, quibus diversis hæc in locis fungendis est destinata. Pedum est corporis onus sustentare. Fieri autem nequiret, quin, quæ ab hoc onere facienda sit pressio, sensibilibus quas cuticula tegit partibus noxam sit illatura, nisi ea crassior, proindeque ad eas defendendas aptior formaretur. Digitos idonea ad res eos tangentes alias ab aliis distinguendas sensibilitate præditos esse oportet, simulque adversus duras, inequales, et asperas harum rerum superficies munitos. Ad id muneris obeundum, optime omnium hoc in loco comparatus est medius crassitie gradus. Labia aspero noxiorum corporum tactui parum exposita sunt, proptereaque parva defensione egent; verum opus est ut perquam flexilia sint, quo multas necessarias actiones, ut loquendi, cibum capiendi, et similium, recte exsequi possint.

Neque in diversis tantum corporis partibus, ad usus quibus inservitura est idoneam hoc pacto nacta est cuticula naturam: verum facultas ei præterea est data primigenam suam indolem immutandi, ita ut ad quamcumque vitæ rationem, sive sponte arreptam, sive ex necessitate nobis impositam, sese accommodet, atque adeo pro majore quæ ei sustinenda est frictionis pressionisve mensura, crassior ea rigiorque evadat: dummodo tamen non tanta sit hæc frictio pressiove, quanta ejus structuram labefactare, eamque a partibus quas tegit divellere possit. Si ultro vel coacti multum deambulamus, brevi temporis spatio pedum nostrorum cuticula adeo crassa fit ac robusta, ut nos a dolore molestiaque sentienda sospites tueatur. Si fors ferat, vel summo mortalium Moderatori ita sit visum, ut duro manuum labore vita nobis toleranda sit, ita efficiæ sunt hæc manus, ut quantumlibet asperis rigidissimorum durissimorumque ferramentorum frictionibus sustinendis, imo et omnia confumentis ignis impres-

sionibus

fionibus retundendis, cito pares fiant. Si denique ea nobis data sit vivendi conditio, ut, ad cibaria paranda, onera humeris portare necesse sit, ab ea quam tenera cuticulā nobis antea pepererat molestia paulatim liberamur, hæcque onera quasi leviora brevi tempore evadunt.

Quas in morbis cuticula subit mutationes ultra modum variæ sunt. Liquores aquosos in pustulis continendo, aut purulentam abscessuum materiam absorbendo, mollior ea efficitur, magis extensilis, spissior, laceratuque facilior. In febribus ardentibus sæpe arida fit, rimas agit, et frustulatim defluit: ut quis propemodum dici possit, serpentium more, exuvias suas posuisse. In lepra, una cum acri salinaque materia in asperas squamisque similes placentas quasi pinsitur; quæ pulchram nitidamque venustissimæ cutis superficiem in formam fædæ pellis elephantinæ speciem referentem commutant. Verum in his aliisque omnibus quæ diversæ ei superveniunt mutationibus, commodo et utilitati nostræ optime prospectum est. Liquores quippe nostri corporis extra vasa sua delati, cum stagnatione semper acres fiant, cutem quidem destruere, sed non item cuticulam erodere potuerint: at eam laceratu facilem reddendo, paratiorem proinde efficiunt ad cedendum ipsorum evacuationi, cui vel suum pondus vel pressio externa occasionem præbet. Particulæ insuper acres quæ in febre per cutem effluunt, eam quam dixi in cuticula duritiem fissurasque creant, ejusque separatione uberi perspirationi (quæ in ejusmodi casibus maxime salutaris ac necessaria evacuatio est) via sternitur. Postremo, cum tam acres humores in elephantiasi evacuandi sint, feliciter obtigit, quod in tam insensibili parte sedem suam figant, quæ nullo cum nostro detrimento se separare, tamque cito reficere, possit.

Atque hæ præcipuæ sunt cuticulæ, quatenus ea super corporis nostri superficiem extenditur, proprietates et phænomena. Ex his nonnullorum causas, quoad mihi rationes suppetebant, explicare sum adnixus: quædam simpliciter memorare, nullo eorum rationes reddendi facto conatu, satis habui; consultius nimirum ratus, me ejusmodi incepto imparem fateri, quam parum certas conjecturas proferendo, meam, coram tam illustri caetu, temeritatem prodere. Reliquum erat ut externi hujus corporum nostrorum tegumenti, quatenus illud ad partes internas continuatur, vestigia persequeretur. Verum cum id ultra consuetos hoc in loco perorandi limites me longe abduceret, hic finem facio; spem interea fovens

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de hac me materia tantum dixisse, quantum ei quod mihi proposui instituto satisfacturum videatur. Hinc certe illustri quasi exemplo commonstratum habemus, quam mirifice sapienterque nostri corporis fabrica sit contexta. Hinc perspicuo documento ostenditur benignissima maximi Creatoris clementia, qui, flexilem hanc insensilemque membranam inter corpora externa acutumque tactus organum interponendo, efficit ut tangendi voluptate, absque doloris mixtura, frueremur; qui hoc nobis beneficium factum, tectum conservavit, indita sciz. cuticulæ nostræ ejusmodi natura, quæ a rebus alias quolibet corporis nostri partes devastantibus corrumpi nequeat; qui varias quibus vita nobis agenda est rationes prospiciens, huic corporis operimento indolem suam fabricamque mutandi, seque ad eas attemperandi, facultatem impertivit. Hoc pacto se cuticula extendit vel contrahit, crassior tenuiorve evadit, se separat redindegratque, quatenus saluti utilitatique nostræ maxime conducat. Quin tanta nos profecutus est mundi Fabricator indulgentia, ut in his etiam casibus in quibus nostra ipsorum culpa, et (quod cum mærore fatendum est) immoderata cupiditate et stultitia, pœnam commeriti sumus, ad nos miseria liberandos cuticula inserviat; id est, proprietatibus suis a dolore, aliisque diris quibus in morbis alioquin objectaremur eos comitantibus malis, sospitet atque defendat.

Nº 54.

A N

E S S A Y

O N

COMPARATIVE ANATOMY.

ORIGINAL ADVERTISEMENT
TO THE
ANONYMOUS EDITION.

THE following Sheets were found among the Papers of a Physician lately deceased, and sent by a Friend of his to the Bookseller, with liberty to print them. As the subject appeared useful, they were presented to two eminent Physicians in town for their approbation: One of them was so good as to write the following Letter, which, with difficulty, we obtained leave to print, as it will serve for a Preface to the whole. From what he there says, in relation to the Subject and Treatise, we presume the publishing it must be a Service done the Public.

L E T T E R, &c.

S I R,

I HAVE read over the papers on COMPARATIVE ANATOMY, which I now return you with thanks by this bearer. You desire my thoughts on the subject and treatise; and indeed the pleasure I had in the perusal makes your demand but just. What is called *Comparative Anatomy* was certainly the first branch of the science that was cultivated; and from it the earliest anatomists formed their notions and system of the human body. The natural prejudices of mankind, and, in some sense, common humanity, opposed any attempts to be made in the other way. As the first physicians were philosophers, and this part of natural knowledge more immediately related to medicine, they particularly applied to it. Democritus, who, according to some, was the master of Hippocrates, spent much time in dissecting brutes and examining their several parts. He applied himself with such eagerness to this study, as to incur the censure of madness. His design was to examine the nature of the bile, and learn the seat and causes of diseases. That this science was much improved by the times of Hippocrates, is very apparent from his writings, which are intermixed with reasonings drawn from it; and some parts of his physiology are only applicable to brutes. These passages appear to us exceeding obscure, often false and contradictory; and have for that reason been rejected by some very great critics. But is not this owing to our own ignorance? We do not well understand the then received system of anatomy, and his terms and names do not correspond to ours. The small tract *de Vulneribus Capitis*, is, I think, as great a master-piece in its kind as the *Coacæ Prædictiones*. Yet the first has been esteemed by some lame and imperfect, and afforded occasion for many disputes and wranglings; and all this because not understood. Anatomists, however, have done by Hippocrates in most cases as the critics with Homer, made him the master of all human and divine science. Not a new division of a bone, or dispute about a process or articulation, but has been referred to his judgment; and he has often been made to explain what he never dreamt of. Galen, the father of anatomists, is, for the same reason, in many places, become an obscure writer. He is accused and defended by the greatest succeeding masters. Vesalius, the great restorer of anatomy, will not allow accuracy or truth in many of his descriptions; they are, according to him, taken from brutes, and obtruded on the world for human.

The other anatomists treat Vesalius much in the same manner; and, with uncommon sagacity and unwearied application, have found out variations and *lusus naturæ* in particular parts, that they may establish Galen's descriptions, and condemn those of Vesalius. This is particularly the case with Eustachius in his Treatise on the Kidneys. How shall we now understand Galen, and judge between these great anatomists? It is Comparative Anatomy alone can extricate us from this confusion; as it will teach us when Galen and others described and reasoned from brutes, and when not. We shall then find, I believe, that the greatest part of his descriptions was taken from brutes, which he transferred by analogy to the human body, and so are inaccurate; that a few were taken from the human subject, and are not capable of being otherwise applied. This study he himself recommends with great earnestness to his scholars; and it is observable, that the most eminent anatomists first discovered their genius by an early attachment to it. This was particularly the case of Vesalius and Valsalva*.

As the first knowledge the ancients gained in anatomy was from the dissection of brutes, so they formed the names and terms of art from the most natural appearance the part afforded, and that in different animals. Those names were applied to the corresponding parts in the human body, and retained by succeeding anatomists to avoid a multiplicity of words. This, however, produces one bad effect, that it must mislead us in our conceptions, as those names are often very improper epithets in the human subject. The author has elegantly remarked several of these. The name of *right* and *left* ventricle is apt to give a wrong idea of the position of the heart; and the aorta *ascendens* and *descendens* has imposed on some of the masters in anatomy, who, it is plain, have taken their figures from the name. Disputes have arisen about the *appendix vermiformis*, &c. which are all cleared up when we once view the part in the animal whence the name was taken. A short technical dictionary, with an account of the subjects whence the names of the several parts were derived, would be of great use to students, and is one of the desiderata in anatomy†.

The intention of nature in the formation of the different parts, can nowhere be so well learned as from this science; that is, if we would understand physiology, and reason on the functions in the animal œconomy, we must see how the same end is brought

* Gaudebat enim avicularum, aliorumque animalculorum dissectionibus; eorumque exactius, quam pro illa ætate, rimabatur: quam ego præsignificationem, non in Vesalio tantum, sed in aliis quoque pueris fuisse scio, qui, cum adoleviscent, anatomix penitus se dediderunt. *Morgagni Comment. de vita Valsalvæ.*

† Such a treatise might in a great measure be collected from Sylvius's works, and Fœsius's *Oeconomia Hippocratis*. Camerarius did such a work under the title of Διασκευη νοσηστικη; but it is a rare book.

brought about in other species. We must contemplate the part or organ in different animals, its shape, position, connection with the other parts, &c. and observe what thence arises. If we find one common effect constantly produced, though in a very different way, then we may safely conclude that this is the use or function of the part: this reasoning can never betray us, if we are but sure of the facts. The writers in physiology have generally taken another route, and one favourite thesis or other serves to explain the whole or most of the system. An innate and concocting heat, acids, menstruums, &c. have all had their successive reigns and patrons: and in truth, physicians seem not to have sufficiently considered the importance of this study to form a complete physiology, which must ever be the great basis of their art. They have bestowed pains in examining the human body, dissected minutely its several parts, traced out (perhaps often invented) a new division of a muscle: But how little has physic been promoted by all this? The most accurate description of the human stomach, with all its veins, arteries, nerves, &c. will never rightly explain digestion. What must we then do? Examine it in the other species of animals, mark there its differences and the effects, compare these with the human; and then shall we, in some measure, be able to judge what are the principal instruments, and how they are employed in this compound action. Any other way of reasoning (as the author well observes) will never bring us to the solution of a philosophical or medical problem. It must indeed be confessed, that this method is tedious and slow; many observations must first be made, and the labour of searching and examining gone through, before we can have proper materials to build on. Yet these are the hard conditions on which the knowledge of natural causes is to be obtained; which, as a great genius says, *Tam facile solertia vinci possunt, quam solent conatibus vulgaribus difficulter cedere.*

Of this kind of reasoning we have many beautiful instances in the following papers. Such is the account of the position of the Duodenum; of the cause of our preferring the Right Arm; of the circulation of the blood in the Fœtus; the history of the Thymus and Thyroid Glands, their use and mutual proportion; the use of the Spleen, &c. This last he explains in so short and masterly a manner, that you will find more argument in the few lines upon it than is to be collected from whole treatises on the subject. But as his design was to give a description of the several species, or rather their principal differences, he chiefly confines himself to this. So in the anatomy of the dog he compares the different position, shape, length, &c. of the several parts with the corresponding parts in man; and from that one circumstance, the difference of an erect and horizontal posture, explains all the variations. This reasoning then gives solution to many difficulties in the human anatomy; why the Spleen is so firmly attached to the Diaphragm; why the Omentum reaches only so far; why the posterior part of the Bladder is only covered by the Peritoneum, &c. There have been disputes about the fissure in the human liver, and different accounts given. These all vanish, when we consider

consider this viscus in different animals. We then find that there are more or fewer divisions, according to the greater or lesser flexibility of the spine. The same rule holds with regard to the divisions of the lungs. This reasoning likewise excludes the pretended use of the ligament in the human liver. And in short we can understand but little of our own structure unless we study that of other animals: we shall then find, that the several variations are relative, and depend on the different way of life; that is, one leading speciality draws after it a great many more, in which nature is always an œconomist, and takes the shortest route.

The beautiful gradation of nature in the different orders of beings is very remarkable, and strikes the mind first as being most obvious; but when we take any one species, the case there is still the same, and we observe as surprising a difference. Thus in the animal kingdom, some are provided with lungs, when others are deprived of these breathing organs; some have a muscular diaphragm and strong abdominal muscles, others a mere membrane. It must be very entertaining to learn how these differences and deficiencies are adjusted and supplied: it is then from this science alone we can understand that simplicity of nature which is much talked of, and but little understood. Hence likewise we must learn what to think of animals perfect and imperfect.

Anatomists have made a noise about the different structures of the same part in the human body, and been at great pains to make collections of those *Lusus Naturæ* as they call them; which because they are rare, are for that very reason of no great consequence to be known. The epithet, however, is extremely proper; for the most remarkable of them are transitions from the order or law of nature that obtains in one species to that of another. Thus it has been observed (though very rarely) that the liver was situated in the left hypochondrium: but, as our author remarks, it is not peculiar to it to lie on the right side in animals; for in fowls it lies equally in both, and in fishes mostly on the left.

It is surprising that we have no tolerable treatise on this subject, which is in itself so entertaining and so conducive to promote Medicine. Those who have made attempts this way, have only collected and ranged in order some particular species, such as Birds or Fishes. They have likewise with great labour given us figures and descriptions of them; but all this is little else than mere amusement. It is the structure of their internal organs we seek after, and the manner how the different functions of the animal œconomy are performed. Their histories of these are every way defective and erroneous. There is indeed noble hints to be found in the writings of some of our modern anatomists, particularly those of the immortal Dr Harvey. That great man well understood the importance of this science to advance medicine; and accordingly employed the most of his time in dissecting animals of different tribes, and making experiments on them: by which means he made the greatest discovery that ever was in the science,

science, and laid the foundation of the present system. He had certainly left us other treatises on this subject, had he not been interrupted by the civil wars. The physicians who lived then, imitating his example, made many new experiments on the bodies of brutes, changing their juices by transfusing of new liquors, accurately marking the effects, &c. that all this might be transferred to the human body: And indeed, from the application of these reasonings to the observations they made on morbid bodies, the science seemed fast advancing to that physical certainty which can be attained from experiment and observation. But alas! this spirit died with these great men, and theory and calculation came in its place. Mathematics, it was said, could alone bring the science to certainty, and throw out conjecture. The quantity and velocity of the blood, the force of the heart, diameters of the vessels, &c. were subjected to measure and number, and diseases next were to be accounted for, all in a mathematical manner.—This method however did not succeed according to wish: for, first, those great geniuses disagreed widely in their calculations, and differed from one another; whence, in place of certain conclusions, we had only wranglings and disputes: not to mention, that some of them made such estimates as must plainly appear ridiculous at first sight*. This, you will say, proves nothing; it was the fault of the artists, who assumed wrong hypotheses for their calculations, or were not perhaps accurate enough in their observations. True; but whose fault was it to adapt figure and number to a subject which refuses them, through its numberless deviations from fixed laws and conditions?—Is an animate body a mere bundle of hard conical elastic tubes, and the heart a pump forcing the liquors through? Are then all the vessels exact cones, or have any two anatomists agreed in their measures of them? Do they not yield every way? and are they not continually obstructed in different places? Are there not many different attractions prevailing for the several secretions, and many different forces acting on the vessels at the same time, which can never be determined? &c. These and such like considerations will soon convince us how little the practice of medicine is to be promoted by those speculations †. If these gentlemen meant by mathematical reasoning

* The ingenious Dr Pitcairn was the chief man in these parts who gave into this way. He supposes the force of the muscles to be in a compound ratio of their length, breadth, and depth; that is, as they are homogeneous solids in the ratio of their weights. Whence knowing the force of any one muscle, we can by the rule of Proportion (from their weights) determine that of another. This he applies to the stomach, and by the computation its muscular force is equal at least to 117088 lb. weight.—That muscles are in that proportion, is a mere hypothesis, for which the Doctor does not offer the smallest proof; and had he assigned five ounces as the weight of the stomach, he had been nearer the truth. This is one glaring instance, how much theory and whim may prevail with the greatest of men over common sense.

† The authority of Hippocrates is often adduced in this argument, for which they cite two passages.

soning physical experiments, then no one ever doubted of this, no more than they do of the use of mathematics in natural philosophy itself. But as this seems not to be their sense of the matter, they should point out a few diseases which this science has explained, and wherein it has corrected the received practice.—But I am quite got from the subject to what is foreign. To return then, Comparative Anatomy has hitherto been treated but by pieces. Thus some, writing on the human eye, have examined the eyes of other animals; and so with regard to the heart, &c. Some have given us the description of one particular animal, others of another. But no one author, as I know of, has given us a system of this science where we might have a summary view of the most material differences in the structure of animals. There are indeed compends of this science, if you will, which are esteemed by many, and were wrote with the noble design of illustrating the wisdom and goodness of our Maker. But those who composed them were not anatomists themselves, so could only collect from others, which they often do without any judgment: for how voluminous soever their works may be, yet if you will strip them of their repeated exclamations, citations of authors and books, the many strange and surprising stories, all told however by creditable vouchers, you will have little left behind besides an indigested chaos of histories and descriptions, some true and many false. The argument however was popular, and they could not fail of pleasing.

The author of these few sheets is certainly a great master of the subject; and has here laid down an useful plan, which it will not be difficult for others to complete. The descriptions, it is easy to see, are all taken from the life; and his reasoning is plain and conclusive. These are intermixed with many practical observations in Medicine and Surgery, which must equally instruct and entertain the Reader.—You have now a few loose reflections on this subject, wherein I have entirely confined myself to that light in which it is here treated. I shall only remark one thing more, that the author's modesty is at least equal to his capacity and knowledge; a rare quality to be met with in an anatomist! Read him on the subject of the Human Allantois, and observe his conclusion of the argument. You must then say, it had been happy for the public, if half so much candour and self-diffidence had prevailed in the disputes among the learned. The world had been more instructed, and they more justly esteemed.

I am, Sir, Your most humble Servant.

passages. In the one he recommends the study of Astronomy, as necessary to a physician; and in the other, that of Arithmetic and Geometry.—The first he did from his belief in the influence of the stars; and the second from his veneration for the Pythagoric numbers, in the mysteries of which he founded his theory of the crises in acute diseases: Both these considerations then are foreign to the purpose, nor is there in any of his genuine writings the smallest vestige of this kind of reasoning. On the contrary, Celsus says of him, *Primus ab studio sapientia medicinam separavit.*

A N
E S S A Y
O N
COMPARATIVE ANATOMY.

The INTRODUCTION.

THE principal advantages of Comparative Anatomy are the following. First, It furnishes us with a sufficient knowledge of the different parts of animals, to prevent our being imposed upon by such authors who have delineated and described several parts from brutes as belonging to the human body. Secondly, It helps us to understand several passages in the ancient writers in medicine, who have taken many of their descriptions from brutes, and reasoned from them: their reasonings have often been misapplied (and consequently wrong explained) by the moderns, through a foolish fondness to support their own inventions, or give an air of antiquity to a favourite hypothesis. The third and great use we reap from this science, is the light it casts on several functions in the human œconomy, about which there have been so many disputes among anatomists: These will be in a great measure cleared up by exhibiting

biting the structure of the same parts in different animals, and comparing the several organs employed in performing the same action, which in the human body is brought about by one more complex.

In this view, it is altogether needless to insist on those parts whose use is easily understood when once their structure is unravelled. Thus, for instance, if we be acquainted with the action of the muscles in general, it will not be difficult to determine the use of any particular muscle whose origin and insertion is known, if we at the same time consider the various connections of the bones to which it is fixed, and the different degree of mobility they have with respect to each other: In the same manner, if we know the use of the nerves in general, we can easily assign the use of those nerves which are distributed to any particular part. There is then no occasion for a complete Osteology, Myology, &c. of the several animals we shall treat of; nor need we trouble ourselves about the structure of any of the parts, unless when it serves to illustrate some of the fore-mentioned purposes.

That the first use we proposed from examining the structure of the parts in brutes is real and of consequence, is evident from looking into the works of some of the earliest and greatest masters of anatomy, who, for want of human subjects, have often borrowed their descriptions from other animals. The great Vesalius, although he justly reproves Galen for this fault, is guilty of the same himself, as is plain from his delineations of the kidneys, uterus, the muscles of the eye, and some other parts. Nor is antiquity only to be charged with this, since, in Willis's *Anatomia Cerebri* (the plates of which were revised by that accurate anatomist Dr Lower), there are several of the pictures taken from different brutes, especially the dog, besides those he owns to be such.

We shall give several examples of the second use in the sequel of the work.

The animal kingdom, as well as the vegetable, contains the most surprising variety; and the descent in each is so gradual, that the little transitions and deviations are almost imperceptible. The bat and flying-squirrel, though quadrupeds, have wings to buoy themselves up in the air. Some birds inhabit the waters; and there are fishes that have wings,
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and are not strangers to the airy regions; the amphibious animals blend the terrestrial and aquatic together.

The animal and vegetable kingdoms are likewise so nearly connected, that if you take the highest of the one, and the lowest of the other, there will scarce be preserved any difference: For instance, what difference is there betwixt an oyster, one of the most inorganised of the animal tribe, and the sensitive plant, the most exalted of the vegetable kingdom? They both remain fixed to one spot, where they receive their nourishment, having no proper motion of their own, save the shrinking from the approach of external injuries. Thus we observe a surprising chain in nature.

As there is then such a vast variety, it is not only needless, but impossible, to consider all of them particularly. We shall take only some of the most remarkable genera; and hope, from what will be said of them, any of the intermediate degrees may be understood.

In treating of QUADRUPEDS, we shall divide them into the carnivorous and herbivorous. As an instance of these last, we shall take the ruminant kind. The FOWLS we shall divide into those that feed on grain, and those that feed on flesh. The distinction we shall make in treating of FISHES, shall be of those that have lungs, and those that have them not. The first indeed are with difficulty procured, and at the same time differ very little from quadrupeds.

As the structure of insects and worms is so very minute, and lends us but little assistance for the ends proposed, we purposely omit them.

In inquiring into the structure of different animals, we ought to be previously acquainted with the form of their body, manner of life, kind of food, or in short with their natural history; which will lead us to account for the reason of their different structure, and thence explain the actions of the human body.

OF QUADRUPEDS in general.

ALL quadrupeds have a covering of hair, wool, &c. to defend them from the injuries of the weather; which varies in thickness according to the season of the year, and difference of the climate. Thus in Russia and the northern countries, the furs are very thick and warm; while the little Spanish lap-dogs, and Barbary cows, have little or no hair at all.

The *cutis* and *cuticula* in quadrupeds are disposed much in the same way as the human, only more elastic. Immediately under this there is a very thin cutaneous muscular substance, called *panniculus carnosus*, which is common to all quadrupeds, the porcine kind excepted: this principally covers the trunk, serving to shrivel the skin, in order to drive off insects, their tails and heads not being sufficient for this purpose, while their extremities are employed in their support and progression.

It has probably been from observing some muscles of the human body, such as the *platysma myoides*, *cremaster*, and *frontales*, and the collapsed *tunica cellulosa* of emaciated subjects, to resemble this thin muscle, that some of the older anatomists reckoned such a *panniculus* among the common teguments of the human body. This Carolus Stephanus has well observed.

Most part of quadrupeds want clavicles, whereby their anterior extremities fall upon their chest, so as to make their thorax proportionally narrower than the human. This small distance of their anterior extremities is very necessary for their uniform progression: Apes indeed and squirrels have clavicles, to allow them a more full use of their extremities in climbing; but when they sit down on all-fours, they walk but indifferently.

The ANATOMY of a DOG.

WE may first observe of this animal, as indeed of most quadrupeds, that its legs are much shorter in proportion to its trunk, than in man, the length of whose steps depends entirely on the length of his inferior

inferior extremities : however, to balance this, the trunk of the animal is proportionally longer and smaller, and his spine more flexible, by which he is able at each step to bring his posterior extremities nearer to his anterior. His common teguments are much a-kin to those of other quadrupeds: Only they allow little or no passage for sweat; but, when he is over-heated, the noxious and superfluous matter finds an exit by the salivary glands, for he rolls out his tongue and flavers plentifully.

The pyramidal muscles are wanting; to supply which, the rectus is inserted fleshy into the os pubis.

The *omentum* reaches down to the os pubis; which, considering the posture of the animal, we will find to be a wise provision, since its use is to separate an oily liquor for lubricating the guts, and facilitating their peristaltic motion. So in our erect posture the natural gravity of the oil will determine it downward; but in the horizontal position of these creatures, if all the intestines were not covered, there would be no favourable derivation of the fluid to the guts lying in the posterior part of the abdomen, which is the highest: and besides, had the omentum reached much farther down in us, we had been in continual hazard of an epiplocele; which the dog is not subject to, as his viscera do not press so much on the rings of the abdominal muscles. The inferior and anterior lamella of the omentum is fixed to the spleen, fundus of the stomach, pylorus, liver, &c. in the same way as the human; but the superior having no colon to pass over, goes directly to the back-bone. This serves to explain the formation of the small omentum in the human body; which is nothing but the large omentum, having lost its fat, passing over the stomach and colon, where it reassumes its pinguedo, so proceeds, and is firmly attached to the liver, spine, &c. The stræ of fat are pretty regularly disposed through it, accompanying the distribution of the blood-vessels to guard them from the pressure of the superincumbent viscera.

This animal's stomach, though pretty much resembling the human in its shape, is somewhat differently situated. It lies more longitudinal, as indeed all the other viscera do to accommodate themselves to the shape of the cavity in which they are contained; that is, its inferior orifice is much farther down with respect to the superior than the human: by this means
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the gross food has an easier passage into the duodenum. Again, the fundus of the human stomach, when distended, stands almost directly forwards, which is occasioned by the little omentum tying it so close down to the back-bone, &c. at its two orifices; but it not being fixed in that manner in the dog, the fundus remains always posterior: this also answers very well the shape of the different cavities, the distance betwixt the cardia and fundus being greater than that betwixt the two sides. It seems to be much larger in proportion to the bulk of the animal than the human, that it might contain a greater quantity of food at once; which was very necessary, since this animal cannot at any time get its sustenance as men do. The turbillion is not so large, nor is there any coarction forming the *antrum Willisi* as in the stomach of man. It is considerably thicker and more muscular than ours, for breaking the cohesion of their food, which they swallow without sufficient chewing. Hence it is evident the force of the stomach is not so great as some would have it, nor its contraction so violent: otherwise that of dogs would be undoubtedly wounded by the sharp bones, &c. they always take down; for the contraction here is still greater than in the human stomach, which is much thinner. The rugæ of the tunica villosa are neither so large, nor situated transversely, as in the human; but go from one orifice to the other: the reason of which difference is, perhaps, that they might be in less danger of being hurt by the hard substances this creature frequently feeds upon; and for the same reason there is not the like coarction at their pylorus.

The intestines of this animal are proportionally much shorter than ours: for the food which these creatures mostly use, soon dissolves, and then putrifies; on which account there was no occasion for a long tract of intestines, but on the contrary that it should be quickly thrown out of the body. The same is to be observed of all the carnivorous animals. The muscular coat of the intestines is also stronger than the human, to protrude the contents quickly and accurately.

The valvulæ conniventes are less numerous, and in a longitudinal direction.

The *duodenum* differs considerably in its situation from the human. For in man it first mounts from the pylorus upwards, backwards, and
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to the right-side; then passes down by the gall-bladder; and, marching over the right kidney and superior part of the psoas muscles, makes a curvature upwards; and passes over the back-bone and vena cava inferior, to the left hypochondrium, where it gets through the omentum, mesentery, and mesocolon, to commence *jejunum*, being firmly tied down all the way, the biliary and pancreatic ducts entering at its most depending part: Whereas, in the dog, the duodenum is fixed at the pylorus to the concave surface of the liver, and hangs loose and pendulous with the mesentery backwards into the cavity of the abdomen; then turning up again is fixed to the back-bone, where it ends in the jejunum; the bile and pancreatic juice are poured into it at the most depending part. Therefore the same intention seems to have been had in view in the formation of this part in both, *viz.* the giving the chyle, after the liquors of the liver and pancreas are poured into it, a disadvantageous course, that so it might be the more intimately blended with the humours before its entry into the jejunum, where the lacteals are very numerous: And thus, by reason of their different posture, the same design (though by a very different order of the parts) is brought about in both.

The other small guts are much the same with ours, only shorter. The great guts are also shorter and less capacious than in the human body; and we take it for a general rule, that all animals that live on vegetable food, have not only their small guts considerably longer, but also their great guts more capacious, than such creatures as feed on other animals. Hence man, from this form of his intestines, and that of the teeth, seems to have been originally designed for feeding on vegetables chiefly; and still the most of his food, and all his drink, is of that class.

The reason of this difference seems to be, that as animal-food is not only much more easily reduced into chyle, but also more prone to putrefaction, too long a remora of the juices might occasion the worst consequences. So it was necessary that their receptacles should not be too capacious; but on the contrary, being short and narrow, might conduce to the seasonable discharge of their contents. Whereas vegetable food being more difficultly dissolved and converted into an animal nature, there was a necessity for such creatures as fed on it to be provided with a long internal canal, that this food in its passage might be considerably

ably retarded, and have time to change its indoles into one more agreeable to our nature. Besides which, there is another advantage which accrues to man in particular, from having his great guts very capacious: for as he is a rational being, and mostly employed in the functions of social life, it would have been very inconvenient as well as unbecoming for him to be too frequently employed in such ignoble exercises; so that, having this large reservoir for his *fæces alvinæ*, he can retain them for a considerable time without any trouble.

The *appendix vermiformis* justly enough deserves the name of an *intestinum cæcum* in this subject, though in the human body it does not; and it has probably been from the largeness of this part in other animals, that the oldest anatomists came to reckon that small appendicle in man as one of the great guts. On its internal surface we observe a great number of mucous glands.

The *colon* has no longitudinal ligaments; and consequently this gut is not purged up into different bags or cells, as the human: nor does this intestine make any circular turn round the abdomen; but passes directly across it to the top of the os sacrum, where it gets the name of *rectum*.

At the extremity of the *intestinum rectum*, or verge of the anus, there are found two bags or paunches, which contain a most abominable fetid mucus, for which I know no use, unless it serves to lubricate the strained extremity of the rectum, and defend it against the asperity of the *fæces*, or to separate some liquor that might otherwise prove hurtful to their bodies. There is nothing analogous to those sacs in the human subject, unless we reckon the mucilaginous glands that are found most frequent and largest about the lower part of the rectum.

The *mesentery* is considerably longer than in the human body; as, in his horizontal situation, the intestines may rest securely on the soft cushion of the abdominal muscles. The fat is here disposed in the same way, and for the same reason, as in the omentum. The interstices betwixt the fat are filled with a fine membrane. Instead of a great number of glandulæ vagæ to be found in the human mesentery, there is only one large gland to be observed in the middle of the mesentery of a dog, which, from its imagined resemblance to the pancreas and the name of its discoverers, is called *pancreas Ajellii*. The reason why this in man is as it

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were subdivided into many smaller ones, may possibly be, that as the guts of a human body are proportionally much longer than those of this creature, it would have been inconvenient to have gathered all the *lactea primi generis* into one place; whereas, by collecting a few of these vessels into a neighbouring gland, the same effect is procured much more easily.

The *pancreas* in man lies cross the abdomen, tied down by the peritoneum; but the capacity of this creature's abdomen not allowing of that situation, it is disposed more longitudinally, being tied to the duodenum which it accompanies for some way. Its duct enters the duodenum about half an inch below the others.

The *spleen* of this animal differs from ours very much, both in figure and situation. It is much more oblong and thin, and lies more according to the length of the abdomen, like the pancreas. Though the spleen of this creature is not firmly tied to the diaphragm (which was necessary in our erect posture to hinder it from falling downwards), yet by the animal's prone position, its posterior parts being rather higher than the anterior, it comes to be always contiguous to this muscle, and is as effectually subjected to an alternate pressure from its action as the human spleen is.

The human *liver* has no fissures or divisions, unless you please to reckon that small one betwixt the two *pylæ*, where the large vessels enter: Whereas in a dog, and all other creatures that have a large flexion in their spine, as lions, leopards, cats, &c. the liver and lungs are divided into a great many lobes by deep sections, reaching the large blood-vessels, which in great motions of the back-bone may easily shuffle over one another; and so are in much less danger of being torn or bruised, than if they were formed of one entire piece, as we really see it is in horses, cows, and such creatures as have their back-bone stiff and immoveable. There is here no *ligamentum latum* connecting the liver to the diaphragm, which in our situation was necessary to keep the viscus in its place: whereas, in this creature, it naturally gravitates forwards, and by the horizontal position of the animal is in no danger of pressing against the vena cava; the preventing of which is one use generally assigned to this ligament in man. Had the liver of the dog been thus connected to the diaphragm, the re-

piration must necessarily have suffered; for, as we shall see afterwards, this muscle is here moveable at the centre, as well as at the sides: But in man the liver is fixed to the diaphragm, mostly at its tendinous part; that is, where the pericardium is fixed to it on the other side; so that it is in no danger of impeding the respiration, being suspended by the mediastinum and bones of the thorax. In consequence of this viscus being divided into so many lobes, it follows that the hepatic ducts cannot possibly join into one common trunk till they are quite out of the substance of the liver.

We come next, after having examined the chylopoietic viscera, to discourse of those organs that serve for the secretion and excretion of urine. And first of the kidneys; which in this animal are situated much in the same way as in the human subject, but have no fat on their inferior surface, where they face the abdomen, and are of a more globular form than the human. The reason of these differences will easily appear, if you compare their situation and posture in this animal with those in a man who walks erect. They are placed in this subject in the inferior part of the body, so are not subject to the pressure of the viscera, which seems to be the principal cause of the fatness of those organs in us, and perhaps may likewise be the cause of our being more subject to the stone than other animals. Hence there is no need of any cellular substance to ward off this pressure where there would necessarily be fat collected; but the superior part of their kidneys is pretty well covered with fat, lest they should suffer any compression from the action of the ribs and spine.

In the internal structure there is still a more considerable difference, for the *papillæ* do not here send out single the several *tubuli uriniferi*; but being all united they hang down in form of a loose pendulous flap in the middle of the pelvis, and form a kind of septum medium, so that a dog has a pelvis formed within the substance of the kidney. The only thing that is properly analogous to a pelvis in man is that sac or dilatation of the ureters formed at the union of the *ductus uriniferi*. The reason of these particularities may probably be, that the liquors of this animal, as of all those of the carnivorous kind, being much more acrid than those that live on vegetable food, its urine must incline much to an alkalescency, as indeed the smell and taste of that liquor in dogs, cats, leopards, &c.

&c. evidently shew, being fetid and pungent, and therefore not convenient to be long retained in the body. For this end it was proper, that the fecerning organs should have as little impediment as possible by pressure, &c. in the performing their functions; and for that design, the mechanism of their kidneys seems to be excellently adapted: We have most elegant pictures in Eustachius of the kidneys of brutes, delineated as such, with a view to shew Vesalius's error in painting and describing them for the human.

The *glandulæ* or *capsulæ atrabiliaris* are thicker and rounder than the human, for the same reason as the kidneys.

The *ureters* are more muscular than the human, because of the favourable passage the urine has through them; they enter the bladder near its fundus.

The bladder of urine differs considerably from the human; and first in its form, which is pretty much pyramidal or pyriform. This shape of the dog's bladder is likewise common to all quadrupeds, except the ape and those of an erect posture. In men it is by no means pyriform, but has a large sac at its posterior and inferior part: this form depends entirely on the urine gravitating in our erect posture to its bottom, which it will endeavour to protrude; but as it cannot yield before, being contiguous to the os pubis, it will naturally stretch out where there is the least resistance, that is, at the posterior and lateral parts; and were it not for this sac, we could not so readily come at the bladder to extract the stone either by the lesser or lateral operation of lithotomy. Most anatomists have delineated this wrong; so much, that I know of none who have justly painted it, excepting Mr Cowper in his *Myotomia*, and Mr Rutty. It has certainly been from observing it in brutes and young children, that they have been led into this mistake. The same cause, *viz.* the gravity of the urine, makes the bladder of a different form in brutes: in their horizontal position the cervix, from which the urethra is continued, is higher than its fundus; the urine must therefore distend and dilate the most depending part by its weight.

As to its *connection*, it is fastened to the abdominal muscles by a process of the peritoneum, and that membrane is extended quite over it; whereas in us its superior and posterior parts are only covered by it: hence in

man alone the high operation of lithotomy can be performed without hazard of opening the cavity of the abdomen. Had the peritoneum been spread over the bladder in its whole extent, the weight of the viscera in our erect posture would have so bore upon it, that they would not have allowed any considerable quantity of urine to be collected there; but we must have been obliged to discharge its contents too frequently to be consistent with the functions of a social life: Whereas by means of the peritoneum the urine is now collected in sufficient quantity, the viscera not gravitating this way.

You may take it for a general rule, that those creatures that feed upon animal-food have their bladder more muscular and considerably stronger, and less capacious, than those that live on vegetables, such as horses, cows, swine, &c. whose bladder of urine is perfectly membranous, and very large. This is wisely adapted to the nature of their food: for in these first, as all their juices are more acrid, so in a particular manner their urine becomes exalted; which, as its remora might be of very ill consequence, must necessarily be quickly expelled. This is chiefly effected by its stimulating this viscus more strongly to contract, and so to discharge its contents. That a stimulus is one of the principal causes of the excretion of urine, we learn from the common saline diuretic medicines that are given, which are dissolved into the serum of the blood, and carried down by the kidneys to the bladder: the same appears likewise from the application of cantharides; or without any of these, when the parts are made more sensible, as in an excoriation of the bladder, there is a frequent desire to make water. Accordingly we find these animals evacuate their urine much more frequently than man, or any other creature that lives on vegetable food. And if these creatures, whose fluids have already a tendency to putrefaction, are exposed to heat or hunger, the liquids must for a considerable time undergo the actions of the containing vessels, and frequently perform the course of the circulation, without any new supplies of food; by which the fluids becoming more and more acrid, the creature is apt to fall into feverish and putrid diseases: and in fact we find that fatal and melancholy distemper the *rabies canina*, *vulpina*, &c. frequent in these animals; whereas those that feed

on vegetable food seldom or never contract these diseases but by infection.

Their *spermatic vessels* are within the peritoneum, which is spread over them, and from which they have a membrane like a mesentery, so hang loose and pendulous in the abdomen : whereas, in us, they are contained in the cellular part of the peritoneum, which is tensely stretched over them. At their passage out of the lower belly, there appears a plain perforation, or holes ; and from observing this in quadrupeds, has arisen the false notion of *hernia* or *rupture* among authors. This opening is of no disadvantage to them, but evidently would have been to us ; for from the weight of our viscera, and our continually gravitating upon these holes, we must have perpetually laboured under enterocoeles. This they are in no hazard of, since in them this passage is at the highest part of their belly, and, in their horizontal posture, the viscera cannot bear upon it : and, to prevent even the smallest hazard, there is a loose pendulous semilunar flap of fat, which serves two uses, as it both hinders the intestines from getting into the passage, and also the course of the fluids from being stopped in the vessels, which is secured in us by the cellular substance and tense peritoneum.

There is next a passage quite down into the cavity, where the testicles lie. Had the same structure obtained in man, by the constant drilling down of the liquor which is secreted for the lubricating of the guts, we should always have laboured under an hydrocele ; but their posture secures them from any hazard of this kind : indeed your very fat lap-dogs, who consequently have an overgrown omentum, are sometimes troubled with an epiplocele.

The *scrotum* is shorter and not so pendulous as the human in all the dog kind that want the *vesiculæ seminales*, that the seed at each copulation might the sooner be brought from the testes, thus in some measure supplying the place of the *vesiculæ seminales* ; for the course of the seed through the *vasa deferentia* is thus shortened, by placing the secreting vessels nearer the excretory organs. The want of *vesiculæ seminales* at the same time explains the reason why this creature is so tedious in copulation.

The structure of the *testicles* is much the same with the human ; as are
likewise

likewise the *corpus pyramidale, varicosum*, or *pampiniforme*, and the *epididymis* or excretory vessel of the testicle. The *vasa deferentia* enter the abdomen where the blood-vessels come out; and, passing along the upper part of the bladder, are inserted a little below the bulbous part of the urethra.

The præputium has two muscles fixed to it: one that arises from the sphincter ani, and is inserted all along the *penis*; and this is called *retractor præputi*: but the other, whose office is directly contrary to this, is cutaneous, and seems to take its origin from the muscles of the abdomen, or rather to be a production of their tunica carnosæ. The *corpora cavernosa* rise much in the same way as the human: but these soon terminate; and the rest is supplied by a triangular bone, in the inferior part of which there is a groove excavated for lodging the urethra. There are upon the penis two protuberant bulbous fleshy substances, at the back of which are two veins, which by the *erectores penis* and other parts are compressed in the time of coition; and the circulation being stopped, the blood distends the large cavernous bodies: after the penis is thus swelled, the vagina, by its contraction and swelling of its corpus cavernosum, grips it closely; and so the male is kept in action some time contrary to his will, till time be given for bringing a quantity of seed sufficient to impregnate the female: and thus, by that *orgasmus veneris* of the female organs, the want of the *vesiculæ seminales* are in some measure supplied. But as it would be a very uneasy posture for the dog to support himself solely upon his hinder feet, and for the bitch to support the weight of the dog for so long a time; therefore, as soon as the bulbous bodies are sufficiently filled, he gets off and turns averse to her: had then the penis been pliable as in other animals, the urethra must of necessity have been compressed by this twisting, and consequently the course of the seed intercepted; but this is wisely provided against by the urethra's being formed in the hollow of the bone. After the emission of the seed, the parts turn flaccid, the circulation is restored, and the bulbous parts can be easily extended.

The *prostatæ* seems here divided into two, which are proportionably larger than the human, and afford a greater quantity of that liquid.

The *uterus* of multiparous animals is little else but a continuation of their
their

their vagina, only separated from it by a small ring or valve. From the *uterus* two long canals mount upon the loins, in which the *fœtuses* are lodged: these are divided into different sacs, which are strongly constricted betwixt each *fœtus*; yet these constrictions give way in the time of birth. From these go out the *tubæ Fallopianæ*, so that the *ovaria* come to lodge pretty near the kidneys.

We ought next to examine the structure of the thorax and its contents. But first it may not be amiss to remark of the *diaphragm* in its natural situation, that it is in general more loose and free than the human; which is owing to its connection with the neighbouring parts in a different manner from ours. The human *diaphragm* is connected to the pericardium; which again, by the intervention of the mediastinum, is tied to the sternum, spine, &c. but here there is some distance between the diaphragm and pericardium. We observe further, that its middle part is much more moveable, and the tendinous parts not so large. And indeed it was necessary their *diaphragm* should be somewhat loose, they making more use of it in difficult respiration than man. This we may observe by the strong heaving of the flanks of an horse or dog when out of breath; which corresponds to the rising of the ribs in us.

The disposition and situation of the *mammæ* vary as they bear one or more young. Those of the uniparous kind have them placed between the posterior extremities, which in them is the highest part of their bodies, whereby their young get at them without the inconvenience of kneeling: nevertheless, when the creatures are of no great size, and their breast large, as in sheep, the young ones are obliged to take this posture. In multiparous animals, they must have a great number of nipples, that their several young ones may have room at the same time, and these disposed over both thorax and abdomen; and the creatures generally lie down when the young are to be suckled, that they may give them the most favourable situation. From this it does not appear to be from any particular fitness of the vessels at certain places for giving a proper nourishment to the child, that the breasts are so placed in women as we find them, but really from that situation being the most convenient both for mother and infant.

The *sternum* is very narrow, and consists of a great number of small bones,

bones, moveable every way; which always happens in creatures that have a great mobility in their spine. The ribs are straighter, and by no means so convex as the human; whereby in respiration the motion forward will very little enlarge their thorax, which is compensated by the greater mobility of their diaphragm: so our thorax is principally enlarged according to its breadth and depth, and theirs according to its length. The want of clavicles, and the consequent falling in of the anterior extremities upon the chest, may contribute somewhat to the straitness of the ribs.

The *mediastinum* in this creature is pretty broad. The pericardium is not here contiguous to the diaphragm, but there is an inch of distance betwixt them, in which place the small lobe of the lungs lodges; and by this means the liver, &c. of this animal, though continually pressing upon the diaphragm, yet cannot disturb the heart's motion.

The heart is situated with its point almost directly downwards, according to the creature's posture, and is but very little inclined to the left side. Its point is much sharper, and its shape more conoidal, than the human. Here the names of *right* and *left* ventricles are proper enough, though not so in the human; which ought rather to be called *anterior* and *posterior*, or *superior* and *inferior*. The animal has the *vena cava* of a considerable length within the thorax, having near the whole length of the heart to run over ere it gets at the *sinus Lowerianus dexter*. In men, as soon as it pierces the diaphragm, so soon it enters the pericardium, which is firmly attached to it, and immediately gets into the *sinus Lowerianus*; which sinus, in the human subject, by the oblique situation of the heart is almost contiguous to the diaphragm: and by this we discover that several authors have taken their delineations of the human heart from brutes; which is easily detected by the shape and situation of the heart, and long *vena cava* within the thorax. This was one of the faults of the curious wax-works that were shown at London and Paris, which were plainly taken from a cow.

This situation of the heart of the creature agrees best with the shape of its thorax, which is lower than the abdomen.

The egress of the large blood-vessels from the heart is somewhat different from the human: for here the right subclavian comes off first; and

and as a large trunk runs some way upwards before it gives off the left carotid, and splits into the carotid and subclavian of the right side, then the left subclavian is sent off: So that neither here, properly speaking, is there an *aorta ascendens* more than in the human; but this name has probably been imposed upon it from observing this in a cow, where indeed there is an ascending and descending aorta.

From this speciality of the distribution of the vessels of the right side, which happens, though not in so great a degree, in the human subject, we may perhaps in some measure account for the general greater strength, readiness or faculty of motion, which is observable in the right arm. I believe, upon measuring the sides of the vessels, the surface of the united trunk of the right subclavian and carotid is less than that of the left subclavian and carotid, as they are separated. If so, the resistance to the blood must be less in that common trunk than in the left subclavian and carotid: but if the resistance be smaller, the absolute force with which the blood is sent from the heart being equal, there must necessarily be a greater quantity of blood sent through them in a given time; and as the strength of the muscles is, *cæteris paribus*, as the quantity of blood sent into them in a given time, those of the right arm will be stronger than those of the left. Now children, being conscious of this superior strength, use the right upon all occasions; and thus from use comes that great difference which is so observable. That this is a sufficient cause, seems evident from fact; for what a difference is there betwixt the right and the left arm of one who has played much at tennis? View but the arms of a blacksmith, and legs of a footman, and you will soon be convinced of this effect arising from using them. But if by any accident the right arm is kept from action for some time, the other from being used gets the better; and those people are left-handed: for it is not to be imagined, that the small odds in the original formation of the vessels should be sufficient to resist the effect of use and habit, (instances of the contrary occur every day); it is enough for our present argument, that where no means are used to oppose it, the odds are sufficient to determine the choice in favour of the right. Now because it is natural to begin with the leg corresponding to the hand we have most power of, this is what gives also a superiority to the right leg.

This difference is not peculiar to man, but is still more observable in those creatures in whom the same mechanism does obtain in a greater degree. Do but observe a dog at a trot, how he bears forwards with his right side; or look at him when a-scraping up any thing, and you will presently see that he uses his right much oftener than he does his left foot. Something analogous to this may be observed in horses.

The *thymus* of this creature is proportionably much larger than ours; whereas the *glandula thyroidea* is much less: and it is generally remarked, that these two glands do thus always supply the place of each other; that is, in such animals as have a large *thymus*, the *glandula thyroidea* is smaller, and *vice versa*. Hence we are naturally led to ascribe the same use to both, viz. the separation of a thin lymph for diluting the chyle in the thoracic duct before it be poured into the blood; then if we consider the different formation of the thorax in both, we shall readily account for the variety in the bulk of these two glands. Respiration being chiefly performed in man by the widening of the chest, the lungs at every inspiration must press upon the *thymus*, and consequently diminish it: but the diaphragm yielding more in the dog's inspiration, this gland is not so much pressed by the lungs, and so will be larger; and hence the *glandula thyroidea* will be proportionably less. Again, from the posture of this creature, we shall see that it was much more convenient for a dog to have the most part of the diluting lymph supplied by the *thymus*, since the neck being frequently in a descending posture, the lymph of the thyroid gland would have a very disadvantageous course to get to the thoracic duct: whereas in the human body, the *thymus* is really below the lacteal canal, where it makes its curvature before it opens into the subclavian; and consequently there is a necessity of a considerable share of the diluting liquor being furnished by the thyroid gland, which is situated much higher; so that its lymph has the advantage of a perpendicular descent.

We may here observe, that the *thoracic duct* in a dog has no curvature before it enters the subclavian vein, the horizontal position of this animal allowing a favourable enough course to the chyle, so as not to need that turn to force its passage into the blood.

The lungs of this creature are divided into more numerous lobes, and deeper,

deeper, than they are in man, for the same reason as the liver. The left side of the thorax in this animal bears a greater proportion to the right than in man; the one being nearly as three to two, the other as four to three.

We look on it as a general rule, that all quadrupeds, as having occasion to gather their food from the ground, are provided with longer necks than man: but as a long neck not only gives the advantage of too long a lever to the weight of the head, but also, when the animal is gathering his food, makes the brain in danger of being oppressed with too great a quantity of blood, by the liquor in these arteries having the advantage of a descent, while that in the veins must remount a considerable way contrary to its own gravity; it was therefore necessary that a part of the length of the neck should be supplied by the length of the jaws. Thus we see horses, cows, &c. who have no occasion for opening their mouths very wide, yet have long jaws. Bull-dogs indeed, and such animals as have occasion for very strong jaws, must of necessity have them short; because the longer they are, the resistance to be overcome acts with a longer lever. Another exception to this general rule, is such animals as are furnished with something analogous to hands to convey their food to their mouths, as cats, apes, &c. The teeth of this creature plainly shew it to be of the carnivorous kind; for there are none of them made for grinding their food, but only for tearing and dividing it.

Even its posterior teeth are not formed with rough broad surfaces as ours are; but are made considerably sharper, and press over one another when the mouth is shut, that so they may take the firmer hold of whatever comes betwixt them.

The tongue, in consequence of the length of the jaws, is much longer than ours; and as this creature feeds with his head in a depending posture, the bolus would always be in danger of falling out of the mouth, were it not for several prominences placed mostly at the root of the tongue, and crooked backwards in such a manner, as to allow any thing to press easily down to the jaws, but to hinder its return. In some animals who feed on living creatures, these under-hooks are still more conspicuous, as in several large fishes, where they are almost as large as their teeth in the forepart of their mouth, and near as firm and strong.

When we open the mouth, we see the *amygdalæ* very prominent in the posterior part of it; so that it would appear at first view, that these were inconveniently placed, as being continually exposed to injuries from the hard substances this creature swallows: but upon a more narrow scrutiny, we find this provided for by two membranous capsulæ, into which the *amygdalæ*, when pressed, can escape, and remove themselves from such injuries.

The *velum pendulum palati* is in this creature considerably longer than in man, to prevent the food from getting into his nose; which would happen more frequently in this animal than in man, because of its situation while feeding.

In this subject there is no *uvula*; but then the *epiglottis*, when pressed down, covers the whole rima entirely, and naturally continues so: there is therefore a ligament, or rather muscle, that comes from the os hyoides and root of the tongue, that is inserted into that part of the epiglottis where it is articulated with the cricoid cartilage, which serves to raise it from the rima, though not so strongly but that it may with a small force be clapped down again.

In the upper part of the pharynx, behind the cricoid cartilage, there is a pretty large gland to be found, which serves not only for the separation of a mucous liquor to lubricate the bolus as it passes this way, but also supplies the place of a valve, to hinder the food from regurgitating into the mouth, which it would be apt to do by reason of the descending situation of the creature's head.

The *œsophagus* is formed pretty much in the same way as the human. Authors indeed generally allege, that quadrupeds have their gullet composed of a double row of spiral fibres decussating one another; but this is proper to ruminating animals, who have occasion for such a decussation of fibres. The action of these you may easily observe in a cow chewing her cud.

The *nose* is generally longer than in man, and its external passage much narrower. The internal structure is also better adapted for an acute smelling, having a larger convoluted surface on which the *membrana Scheideriana* is spread; and this is to be observed in most quadrupeds, who have the *ossa spongiosa* commonly large, and these too divided

ded into a great number of excessively fine thin lamellæ. The elephant, which has a head pretty large in proportion to its body, has the greatest part of it taken up with the cavity of the nose and frontal sinuses; which last extend almost over their whole head, and leave but a small cavity for their brains. A very nice sense of smelling was not so absolutely necessary for man, who has judgment and experience to direct him in the choice of his food; whereas brutes, who have only their senses, must have these of necessity acute, some having one sense in greater perfection than others, according to their different way of life. We not only conclude *à priori* from the large expanded *membrana scheideriana*, that their sense of smelling is very acute, but we find it so by cows and horses distinguishing so readily betwixt noxious and wholesome herbs, which they do principally by this sense.

The external *ear* in different quadrupeds is differently framed, but always calculated to the creature's manner of life. In shape it commonly resembles the oblique section of a cone from near the apex to the basis. Hares, and such other animals as are daily exposed to insults from beasts of prey, have large ears directed backwards, their eyes warning them of any danger before; rapacious animals, on the other hand, have their ears placed directly forwards, as we see in the lion, cat, &c. The slow hounds, and other animals that are designed to hear most distinctly the sounds coming from below, have their ears hanging downwards. Man again, who must equally hear sounds coming from all quarters, but especially such as are sent from about his own height, has his external ear placed in a vertical manner, somewhat turned forward. In short, wherever we see a speciality in the make of this organ in any creature, we shall, with very little reflection, discover this form to be more convenient for that creature than another. There are some differences to be observed in the structure of the internal ear in different animals; but we know so very little of the use of the particular parts of that organ in the human subject, that it is altogether impossible to assign reasons for these variations in other creatures.

All quadrupeds have at the internal canthus of the *eye* a strong firm membrane with a cartilaginous edge, which may be made to cover some part of their eye; and this is greater or less in different animals as their
eyes.

eyes are more or less exposed to dangers in searching after their food. This *membrana nictitans*, as it is called, is not very large in this animal. Cows and horses have it so large as to cover one half of the eye like a curtain, and at the same time is transparent enough to allow abundance of the rays of light to pass through it. Fishes have a cuticle always over their eyes, as they are ever in danger in that inconstant element. In this then we may also observe a sort of gradation.

All quadrupeds have a seventh muscle belonging to the eye, called *suspensorius*. It surrounds almost the whole optic nerve, and is fixed into the sclerotic coat as the others are. Its use is to sustain the weight of the globule of the eye, and prevent the optic nerve from being too much stretched, without obliging the four straight muscles to be in a continual contraction, which would be inconvenient: at the same time this muscle may be brought to assist any of the other four, by causing one particular portion of it to act at a time.

The next thing to be remarked is the figure of the *pupil*, which is different in different animals, but always exactly accommodated to the creature's way of life. Man has it circular for obvious reasons; an ox has it transverse, to take in a larger view of his food: cats, again, have theirs somewhat perpendicular (but can alter it pretty much) for a similar reason, and so of the rest. The pupil of different animals varies in wideness, according as the internal organs of vision are more or less acute: Thus cats and owls, who seek their prey in the night, or in dark places, (and consequently must have their eyes so formed as that a few rays of light may make a lively impression on the retina), have their pupils in the day-time contracted into a very narrow space, as a great number of rays would oppress their nice organs, while in the night they dilate considerably. In the same way, when the retina is inflamed, a great number of rays of light would occasion a painful sensation; therefore the pupil is contracted: on the contrary, in dying people, or in a beginning amaurosis, it is greatly dilated, as the eyes on such occasions are very difficultly affected, and as it were insensible.

The posterior part of the choroid coat, which is called *tapetum*, is of different colours in different creatures. For oxen, feeding mostly on grass have this membrane of a green colour, that it may reflect upon the retina

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all the rays of light which come from objects of that colour, while other rays are obscured: Thus the animal sees its food better than it does other objects. Cats and owls have their tapetum of a whitish colour; and for the same reasons have the pupil very dilatable, and their organs of vision acute: and we shall find that all animals see more or less distinctly in the dark, according as their tapetum approaches nearer to a white or black colour. Thus dogs, who have it of a greyish colour, distinguish objects better in the night than man, whose tapetum is dark brown, and who I believe sees worst in the dark of any creature; it being originally designed that he should rest from all kinds of employment in the night-time. The difference then of the colour of the tapetum, as indeed the fabric of any other part in different creatures, always depends on some particular advantage accruing to the animal in its peculiar manner of life from this singularity.

We shall now proceed to the *brain*, which we remark in the first place is proportionally much smaller in all quadrupeds than the human. There was no such occasion for so great a quantity of brains in those animals as in man; seeing in them all its energy is employed in their progression, while man has a great waste of spirits in the exercise of his reason and intellectual faculties. And besides all this, a great bulky brain would be inconvenient to these creatures, in so far as it would add considerably to the weight of the head; which having the advantage of a long lever to act with, would require a much greater force to support it, than now it does; for the heads of the greatest part of quadrupeds are not near so heavy as they would at first seem to be, from the *sinus frontales* being produced a great way upwards to enlarge the organs of smelling.

The pits in the anterior part of their skulls are much more conspicuous than in the human cranium; which may be occasioned by the depending posture of these creatures heads while they gather their food: the brain at this time gravitating much on the bones while they are as yet soft, will gradually make impressions upon them at these places where it rises into eminencies. This is prevented in man mostly by his erect posture.

The *falx* is not near so large in quadrupeds as in man, as they have little occasion to be on either side, and the two hemispheres of the brain

are.

are in a great measure hindered from jostling against one another in violent motions, by the brain's insinuating itself into the abovementioned pits.

The second process of the *dura mater*, or *tentorium cerebello super-expansum*, is considerably thicker and stronger in most quadrupeds than in man; especially in such of them as are very swift of foot, as hares and rabbits, and that most when they are old. This membrane is generally ossified, that it may the more effectually keep off the weight of the super-incumbent brain from the cerebellum in their rapid motions, which otherwise would be of bad consequence.

The olfactory nerves are very large, and justly deserve the name of *processus mamillaris*. They are hollow, and consist of a medullary and cineritious substance, and at first sight appear to be the anterior ventricles of the brain produced; but in man they are small, and without any discernible cavity. The reason of this is pretty evident, if we consider how this animal's head is situated; for the lymph continually gravitating upon the inferior part of the ventricles may thus elongate and produce them: but from this very inferior part the olfactory nerves rise, and are sent immediately through the *os ethmoides* into the nose. Hence the ancients, thinking they were continued hollow into the nose, believed they were the emunctories of the brain: in the brain of sheep, which by its firm texture is the best subject of any for searching into the structure of this part, we evidently see, that the name of the *sigmoid cavity*, was very properly applied by the ancients to the lateral ventricles of the brain; which are really of a greater extent than they are ordinarily painted by the anatomists, reaching farther backwards, and forwards again under the substance of the brain.

The *nates* and *testes* deserve this name much better here than in the human body, with respect to each other. They are here also of different colours; the *nates* being of the colour of the cortical, and the *testes* of the medullary substance of the brain: whereas, in man they are both of one colour. The reason of these differences, and others of the like nature to be met with, I shall not pretend to determine; for we have hitherto such an imperfect knowledge of the brain itself, that we are entirely ignorant of the various uses of its different parts. We may in general conclude,
that

that the varying in one animal, from what it is in another, is fitted to the creature's particular way of living.

The *rete mirabile Galeni*, situated on each side of the *fella turcica*, about which there has been so much dispute, is very remarkable in most quadrupeds. Galen seems with justice to suppose, that this plexus of vessels serves for checking the impetuosity of the blood destined for the brain.

The structure of the brain differing but very little in all quadrupeds, it will be needless to examine it in any other.

The ANATOMY of a COW.

THE next species of quadrupeds we proposed to consider, was the ruminant kind, of which we have an example in a cow; and accordingly shall take the foetus of the animal *in utero*, that we may first remark some things that are peculiar to it in that state, and afterwards proceed to examine its viscera as a ruminant animal. First then as a foetus.

The form of a cow's *uterus* differs from the human, in having two pretty large cornua. This is common to it with other brutes; for a bitch has two long *cornua uteri*: But these again differ (as being multiparous and uniparous) in this, that in the bitch's cornua the foetuses are contained; whereas here there is only part of the secundines, being mostly the allantois with the included liquor. The muscular fibres of the uterus are more easily discovered; its internal surface has a great number of spongy, oblong, protuberant, glandular bodies fixed to it. These are composed of vessels of the uterus terminating here. In an impregnated uterus, we can easily press out of them a chylous mucilaginous liquor; they are composed of a great many processes or digituli, and deep caverns, answering to as many processes and caverns of the placenta. Their resemblance has occasioned the name of *papillæ* to be given them; and hence it was that Hippocrates was induced to believe that the foetus sucked *in utero*. It is not easy to determine whether the uterus grows thicker or thinner in the time of gestation. The membranes, it is plain, (by the stretching of the parts) must be made thinner; but then it is as evident, that the vessels are at that time enlarged, upon which principally the thickness of any part depends; so there seems to be as much gained the one way, as lost the other.

The *os uteri* is entirely shut up by a glutinous mucilaginous substance, that is common to the females of all creatures when with young: by this the external air is excluded, which would soon make the liquors corrupt; it also prevents the inflammation of the membranes, and the hazard of abortion. By this means also the lips of the womb are kept from growing together, which otherwise they would certainly at this time do. There are mucous glands placed here to secrete this gluten, which on the breaking of the membranes with the contained waters make a sapo that lubricates and washes the parts, and makes them easily yield. The first of the proper involucra of the *fœtus* is the chorion.

The *chorion* is a pretty strong firm membrane, on whose external surface are dispersed a great many red fleshy bodies of the same number, size and structure with the papillæ, with which they are mutually indented. They have been called *cotyledones*, from *κοτύλη*, "cavity." This is greatly disputed by some as a name very improper; but I think without reason, since the surface that is connected to the papillæ is concave, though when separated it appears rather convex. To shun all dispute, they may be called properly enough *placentulæ*, since they serve the same use as the placenta in women. The separation of these from the papillæ without any laceration, and our not being able to inject coloured liquors from the vessels of the glands of the uterus into the *placentulæ*, seem to prove beyond a reply, that there can be here no anastomoses betwixt the vessels; on their coats run a great number of vessels that are sent to the several *placentulæ*, on the external side next to the uterus; whereas in creatures that have but one placenta, as in the human subject, cats, dogs, &c. the adhesion is somewhat firmer: The *placentæ* are likewise joined to the papillæ in the *cornua uteri*. We shall next give the history of the *allantois*.

This is a fine transparent membrane contiguous to the former. It is not a general involucrum of the *fœtus* in the mother, for it covers only a small part of the amnios. It is mostly lodged in the *cornua uteri*. In mares, bitches, and cats, it surrounds the amnios, being every where interposed betwixt it and the chorion. In sheep and goats it is the same as in this animal; and in swine and rabbits it covers still less of the amnios. This sac is probably formed by the dilatation of the urachus, which is connected at its other end to the fundus of the bladder, through

through which it receives its contents, and the membrane is doubled at the extremity of the canal to hinder the return of the urine back into the bladder. Its vessels are so excessively fine and few, that we cannot force an injected liquor farther than the beginning of this coat. This membrane is so far analogous to the cuticula, as not to be liable to corruption, or easily irritated by acrid liquors. The existence of this membrane in women has been very warmly disputed on both sides. Those who are against its existence deny they could ever find it; and, allowing it were so, allege, that since the urachus is impervious, as appears by our not being able to throw liquors from the bladder into it, or *vice versa*, it cannot serve the use that is agreed by all it does serve in beasts, and therefore in the human body there is no such thing. But when I considered on the other hand, first, that there seems to be the same necessity for such a reservoir in man as in other animals: secondly, that we actually find urine contained in the bladder of the human foetus: thirdly, that urine has been evacuated at the navel when the urethra was stopped, which urine without this conduit would have fallen into the cavity of the abdomen: fourthly, that midwives have pretended to remark two different sorts of waters come away at the time of birth: and lastly, that Dr Littre and Dr Hale have given in this membrane of an human subject with all the other secundines curiously prepared, the one to the royal academy at Paris, the other to the royal society at London, by which societies their respective accounts are attested; not to mention Verheyen, Heister, Keil, &c. who affirm their having seen it; and Mr Albinus, that famous anatomist, professor at Leyden, shows, as I am told, to his college every year a preparation of it: On all these accounts I must own, that it seemed not improbable to me there was such a membrane in the human body. But in four bodies I purposely dissected, wherein I was assisted by a very accurate anatomist, Dr Sinclair, I could not observe any such thing. However, my want of skill will more probably be doubted, than the truth of relations supported by such authentic vouchers called in question.

The third proper integument of the foetus is the *amnios*. It is thinner and firmer than the chorion; it has numerous ramifications of the umbilical vessels spread upon it, the lateral branches of which separate a liquor into its cavity. This is the proper liquor of the amnios, which at

first is in a small quantity, afterwards increases for some months, then again decreases, and in a cow near her time the quantity of this liquor is not above a pound. This membrane does not enter the *cornua uteri* in this creature; but for what further relates to the structure of the involucra, with the nature of the liquors contained in them, I must refer to the second volume of Medical Essays, from page 121, where you have the sum of all I know of this matter.

There are here two *venæ umbilicales*, and but one in the human subject; because the extreme branches coming from the several placentulæ could not unite so soon as they would have done had they come all from one cake as in the human.

There is a small round fleshy body that swims in the urine of this creature, mares, &c. which is the *hippomanes* of the ancients. Several idle opinions and whims have been entertained as to its use; but that seems to be still unknown, or how it is generated or nourished; for it has no connection with the foetus or placentulæ.

Having thus considered the several involucra of this animal in a foetus state, let us next observe the specialities in its internal structure peculiar to a foetus.

The umbilical vein joins the *vena portarum* in the *capsula Glissoniana* without sending off any branches as it does in the human subject. This vein soon after birth turns to a ligament; yet there are some instances where it has remained pervious for several years after birth, and occasioned an hæmorrhage. We may next observe the duct called *canalis venosus*, going straight from the *capsula Glissoniana* to the *vena cava*; this turns also afterwards to a ligament. The umbilical arteries rise at acute angles from the internal iliacs, whatever some may say to the contrary: these also become impervious.

The pulmonary artery coming from the right ventricle of the heart divides into two: the smallest, called *canalis arteriosus*, opens into the descending aorta; the other divides into two, to serve the lungs on each side. The *foramen ovale* is placed in the partition betwixt the right and left auricles. At the edge of this hole is fixed a membrane, which when much stretched will cover it all over, but more easily yields to a force that acts from the right auricle to the left than from the left to the right.

After

After what has been said, we may easily understand how the circulation is performed in a foetus. The blood, being brought from the placenta of the mother, is thrown into the *capsula Glissoniana*, where it is intimately blended with the blood in the *vena portarum*: then part of this blood goes directly into the *vena cava* by the *ductus venosus*; the rest passes through the liver. First, then, the whole is sent from the *vena cava* into the right auricle, from whence part of it is sent by the *foramen ovale* into the left auricle; the rest passes into the right ventricle, then into the pulmonary artery; then the greatest share it receives is sent immediately into the descending aorta by the *canalis arteriosus*, and the remainder circulates through the lungs, and is sent back by the pulmonary veins into the left auricle; which, with the blood brought there by the *foramen ovale*, is sent into the left ventricle, from whence it is driven by the aorta through the body. The great design of this mechanism is, that the whole mass of blood might not pass through the collapsed lungs of the foetus; but that part of it might pass through the *foramen ovale* and *canalis arteriosus*, without circulating at all through the lungs.

This was the opinion that universally prevailed till the end of the last century, when it was violently opposed by Monsieur Mery, who is very singular in several of his opinions. He will not allow that the foramen ovale transmits blood from the right to the left auricle, but on the contrary from the left to the right; and that for no other reason but because he observed the pulmonary artery in a foetus longer than the aorta. Mr Winslow endeavours to reconcile these two opinions, by saying the blood may pass either way, and that it is here as it were blended; his reason is, that on putting the heart in water, the foramen ovale transmits it any way. Mr Rohault, professor of anatomy at Turin, and formerly one of Mery's scholars, strongly defends his master, and criticises Mr Winslow. What he principally builds on, is the appearance this foramen has in some dried preparations: This Mr Winslow will not allow as a proof. After all, I remain in the common opinion; and that for the following reasons: First, the pulmonary artery being larger signifies nothing, since its coats are not only thinner and will be more easily distended, but also the resistance to the blood in the pulmonary artery from the collapsed lungs is greater than the resistance to the blood in the aorta. Secondly,

if

if we should allow any of these two uncommon opinions, we should have the right ventricle vastly more capacious than the left: for if we suppose the *foramen ovale* to be capable of transmitting one third of the whole mass of blood in any given time, and the *arteriosus* as much in the same time, then you will find, that, according to Mr Mery's opinion, the whole mass of blood being driven from the right ventricle into the pulmonary artery, one third passes by the *canalis arteriosus* into the descending aorta, two thirds passing through the lungs and returning into the left auricle; one half of which portion, or one third of the whole mass, passes by the *foramen ovale* into the right auricle; and the other, or the last third, will be sent into the left ventricle, and thence expelled into the *aorta*; which third, with that from the pulmonary artery by the *canalis arteriosus*, circulating through the body, are returned unto the right auricle, where meeting with the other third from the *foramen ovale*, with it they are sent into the right ventricle to undergo the same course. Thus the whole mass is expelled by the right ventricle, and only one third by the left. If this was the case, why is not the right ventricle three times as large and strong as the left?

Then, if according to Mr Winflow's system the *foramen ovale* transmits equal quantities from both auricles, this comes to the same as if there was no *foramen ovale* at all: that is to say, the whole mass going from the right auricle into the right ventricle and pulmonary artery, one third of the whole mass passes into the aorta through the *canalis arteriosus*; the other two thirds, passing through the lungs, return to the left auricle and ventricle. Thus the right ventricle expels the whole mass; the left, only one third.

But if, according to the common opinion, we suppose the *foramen ovale* to convey the blood from the right to the left auricle, then one-third passes this way into the left ventricle; the other two-thirds are sent by the right ventricle into the pulmonary artery: from whence one-third passes by the *canalis arteriosus* into the *aorta descendens*; the other third circulates through the lungs, and is returned into the left ventricle; where meeting with that from the *foramen ovale*, it is therewith expelled into the aorta, and with the one-third transmitted by the *canalis arteriosus* returns into the auricle to run the same race as before. Thus we conclude, that two thirds

thirds are expelled by each ventricle, and the whole circulates through the body; and hence they come to be of pretty equal dimensions. In all this calculation I have had no regard to the blood discharged from the umbilical vessels; but the greater quantity returned by the veins, than sent out by the arteries, still argues for the common opinion.

The *kidneys* in the *foetus* are composed of different lobes, which serves to give us an idea of the kidneys being a congeries of different glands; these lobes being kept contiguous by the external membrane are pressed by the other viscera, till at length they unite.

We come now to consider the creature as a ruminant animal. There are no *dentes incisores* in the upper jaw; but the gums are pretty hard, and the tongue rough. The animals therefore supply the defect by wrapping their tongue round a tuft of grass; and so, pressing it against the upper jaw, keep it stretched, and cut it with the teeth of the under jaw; then, without chewing, throw it down into the *oesophagus*, which in these creatures consists of a double row of spiral fibres decussating one another. All animals which ruminate must have more ventricles than one; some have two, some three; our present subject has no less than four. The food is carried directly down into the first, which lies upon the left side, and is the largest of all; it is called γάστρη, *ventriculus*, and κοιλία, by way of eminence. It is what is called by the general name of *paunch* by the vulgar. There are no rugæ upon its internal surface: the food, by the force of its muscular coat, and the liquors poured in here, is sufficiently macerated; after which it is forced up hence by the *oesophagus* into the mouth, and there it is made very small by mastication; this is what is properly called *chewing the cud*, or *rumination*: after this it is sent down by the gullet into the second stomach, for the *oesophagus* opens indifferently into both; however, the creature has a power to direct it into which it will. Some tell us, that the drink goes into the second; but that might be easily determined by making them drink before slaughter. The second stomach, which is the anterior and smaller, is called κεράφυλλος, *reticulum*, *honeycomb*, the *bonnet*, or *king's-hood*. It consists of a great number of cells on its internal surface, of a regular pentagonal figure, like to a honeycomb. Here the food is farther macerated; from which it is protruded into the third, called

called *Exivus* or *omasum*, *vulgo* the *manyplies*, because the internal surface rises up into a great many plicæ or folds, and *stratum super stratum*, according to the length of this stomach. Some of these plicæ are farther produced into the stomach than others, *i. e.* first two long ones on each side, and within these two shorter in the middle, &c. There are numberless glandular grains like millet-seeds dispersed on its plicæ, from which some authors call this stomach the *millet*. From this it passes into the fourth, whose names are *νυστρον*, *abomasum*, *caillè*, or the *red*, which is the name it commonly has because of its colour. *Caillè* signifies *curdled*; and hence the French have given that as a name to this fourth stomach, because any milk that is taken down by young calves is there curdled. It is this fourth stomach, with the milk curdled in it, that is commonly taken for making runnet; but after the bile and pancreatic juice enter, this coagulation is not to be found, which shews the use of these liquors. There are other creatures which use the same food, that have not such a mechanism in their digestive organs. Horses, asses, &c. have but one stomach where grass is macerated, and a liquor for their nourishment extracted, and the remainder sent out by the anus very little altered. From this different structure of the stomach in these creatures, a ruminant animal will be served with one third less food than another of equal bulk: grassers are sufficiently acquainted with this. The reason is, that ruminating animals have many and strong digestive organs; all their food is fully prepared, and almost wholly converted into chyle: but a horse's stomach is not fitted for this; so that he requires a much greater quantity of food to extract the same nourishment.

The guts of these creatures are of a considerable length in proportion to the bulk of the body; and this confirms what we said formerly on the subject of the intestines of a dog, *viz.* that the length and capacity of the guts were different in different animals according to the nature of their food.

The *duodenum* is formed here much the same way as in a dog, and the general intention kept in view with regard to the mixture of the bile and pancreatic lymph. The great guts here hardly deserve that name, their diameter differing very little from that of the small ones; but to compensate this, they are much longer proportionally than a dog's are, being convoluted

convoluted in the same way as the small guts are. The cæcum is very large and long.

The *spleen* differs not much either in figure or situation from that of a dog's; but it is a little more firmly fixed to the diaphragm, there not being here so much danger of this viscus's being hurt in the flexions of the spine.

The *liver* is not split into so many lobes in this creature as either in a man or dog; which depends on the small motion this creature enjoys in its spine, which made such a division needless. This also confirms what I formerly advanced on this head.

Their *vesica urinaria* is of a pyramidal shape. It is very large, and more membranaceous; for the urine of these creatures not being so acrid as that of carnivorous animals, there was no such occasion for expelling it so soon.

This creature is provided with a loose pendulous *scrotum*, and consequently with *vesiculæ seminales*. The female organs differ from those of a bitch, mostly as to the form of the cornua uteri, which are here contorted in form of a snail. In this, and all uniparous animals, they contain only part of the secundines; but in bitches, and other multiparous animals, they run straight up in the abdomen, and contain the foetus themselves.

The situation of the *heart* is pretty much the same with that of a dog, only its point is rather sharper: in us, the heart beating continually against the ribs, and both ventricles going equally far down to the constitution of the apex, it is very obtuse; but here the apex is made up only of the left ventricle, so is more acute.

The *aorta* in this creature is justly divided into ascending and descending, though this division is ill-founded either in a dog or man; and it has certainly been from this subject that the older anatomists took their descriptions when they made this division; for here the aorta divides into two, the ascending and descending.

Of FOWLS in general.

THE next class of animals we come to consider are the feathered kind ; which are divided into the *granivorous* and *carnivorous*. But before we go on to consider the specialties in the viscera of each kind, we must observe what both species agree in.

Fowls have a particular covering of feathers different from all other creatures, but exactly well suited to their manner of life : for it not only protects them from the injuries of the weather, but serves them in their progression through that thin aerial element they are for the most part employed in ; and as some fowls live much in the water, their feathers being continually besmeared with an oily liquor, keeps the water from soaking into their skins, and so prevents its bad effects, which it would infallibly otherwise produce.

Fowls have the strongest muscles of their whole body inserted into their wings ; whence by the way we may observe, that it is altogether impossible for man to buoy himself up into the air like birds, even though he had proper machines in place of wings, unless he were likewise provided with muscles strong enough for moving them, which he has not. In the next place, their wings are not placed in the middle of their bodies, but a good deal further forwards ; whence it would at first view appear, that their heads would be erect, and their posterior parts most depending when raised in the air : but by stretching out their heads, which act upon the lever of a long neck, they alter their centre of gravity pretty much ; and also by filling the sacs or bladders in the inside of their abdomen with air, and expanding their tail, they come to make the posterior part of their bodies considerably higher ; and thus they fly with their bodies nearly in an horizontal situation. Hence we find, that if their necks are kept from being stretched out, or if you cut away their tails, they become incapable of flying any considerable way. The largeness of the wings in different fowls varies according to the occasions of the creature. Thus birds of prey, who must fly a considerable way to provide their food, have large strong wings ; whereas domestic birds, who find their nourishment almost every where, have very short and but small wings. The best account of the manner of progression of fowls is given by Alfonsus Borellus,

Borellus, in his treatise *De Motu Animalium*; and in the *Religious Philosopher* we have Borelli's doctrine stripped pretty much of its mathematical form. The posterior extremities are so situated, as to make us at first think they would be in continual hazard of falling down forwards when they walk; but this is prevented by their holding up their heads and necks; and when they have occasion for climbing up a steep place, they stretch out their head and necks forwards. Thus we may observe a goose entering a barn-door, where generally there is an ascending step, to stretch out its neck, which before was raised, and incline its body forwards. This is laughed at by the common people, who ascribe it to a piece of folly in the goose, as if afraid of knocking its head against the top of the door.

Carnivorous animals are provided with strong crooked claws for the catching their prey: water-fowls use them for swimming; and principally for this purpose have a strong firm membrane interposed betwixt the toes. There is a beautiful mechanism to be observed in the toes of fowls, which is of considerable use to them. For their toes are naturally drawn together, or bended, when the foot is bended: this perhaps proceeds from the tendons of the toes passing over in them, which is analogous to our heels; and when the foot is bended must consequently be much stretched; and since they are inserted into the toes, must of necessity bend them when the foot is bended; and when the foot is extended, the flexors of the toes are again relaxed, and they therefore expanded. This is of great use to water fowls: for had there been no such contrivance as this, they must have lost as much time when they pulled their legs in as they had gained by the former stroke; but, as the parts are now framed, whenever the creature draws in its foot, the toes are at the same time bended and contracted into less space, so that the resistance made against the water is not near so great as before: on the contrary, when they stretch their foot, their toes are extended, the membrane betwixt them expanded, and consequently a greater resistance made to the water. Again, such fowls as live mostly in the air, or have occasion to sustain themselves on branches of trees in windy weather, and even in the night-time when asleep, while all their muscles are supposed to be in a state of

relaxation ; such, I say, have no more to do but lean down the weight of their bodies, and their toes continue bended without any muscles being in action ; and whenever they would disentangle themselves, they raise up their bodies, by which their foot, and consequently their toes are extended.

Carnivorous fowls have their beaks long, sharp, and crooked ; the domestic fowls, such as the hen kind, &c. have strong short beaks, commodiously fitted to dig up and break their food ; the water-fowls again, have long or very broad scoop-like beaks, which is most convenient for them. The *sternum* of fowls is much larger proportionally than the human, and has a ridge rising in its middle for the more commodious origin of the muscles that move the wings. It is also less moveable than ours : for had it been very moveable, a great deal of the force employed for moving the wings would at every contraction of the muscles have been lost, or else some other muscles must have come in play to keep firm the sternum ; but this additional weight would have been inconvenient for their progression.

What other things are most remarkable in the structure of the several viscera, we shall consider in that common domestic animal the cock or hen, and afterwards observe the difference of their *viscera chylopoietica* from a carnivorous fowl.

The ANATOMY of a COCK.

THE *œsophagus* of this creature runs down its neck, somewhat inclined to the right-side ; and terminates in a pretty large membranous sac, which is the ingluvies or crop, where the food is macerated and dissolved by a liquor separated by the glands, which are easily observed every where on the external surface of this bag. The effect of this maceration may be very well observed in pigeons, who are sometimes in danger of being suffocated by the pease, &c. they feed upon, swelling to such an immense bulk in their ingluvies, that they can neither get upwards nor downwards. If it be a favourite fowl, it might be preserved by opening the sac, taking out the pease, and sewing up the wound.

The food getting out of this sac, goes down by the remaining part of the *œsophagus* into the *ventriculus succenturiatus*, or *infundibulum Peyerii*,
which

which is a continuation of the gullet with more numerous glands, which separate a liquor to dilute the food still more, which at length gets into the true stomach or gizzard, which consists of two very strong muscles covered externally with a tendinous aponeurosis, and lined on the inside by a very thick firm membrane, which we evidently discover to be a production of the cuticula. This might have been proved in some measure *à priori*, from taking notice, that this membrane, which in chicks is only a thin flight pellicle, by degrees turns thicker and stronger the more attrition it suffers: but there is no other animal substance, so far as we know, which grows more hard and thick by being subjected to attrition, excepting the cuticula. Hence may be drawn some kind of proof of what I have sometimes affirmed concerning the tunica villosa of the stomach and intestines in the human body, viz. that it was in part a continuation of the epidermis; nay, all the hollow parts of the body, even arteries, veins, &c. seem to be lined with a production of this membrane, or one analogous to it. The use of this internal coat of the stomach of fowls is to defend the more tender parts of that viscus from the hard grains and little stones those creatures take down.

The digestion of these animals is performed merely by attrition, as is evinced by many experiments. We see them daily take down considerable numbers of the most solid rugged little flints they find; and these can serve for no other purpose than to help the trituration of their aliments. After these pebbles, by becoming smooth, are unfit for this office, they are thrown up by the mouth. Hence fowls that are long confined, though ever so well fed, turn lean for want of these stones to help their digestion. But this was put beyond all dispute by Mr Sauvry, who gave a species of metal to an ostrich, convex on one side, and concave on the other, but carved on both; and opening the creature's body some time after, it was found, that the carving on the convex side was all obliterated, while the engraved character remained the same as before on the concave side, which was not subjected to the stomach's pressure: which could not have happened had digestion been performed by a menstruum, or any other way whatsoever; but may be easily solved by allowing a simple mechanical pressure to take place. We are, however, by no means to conclude from this, as some have too rashly done, that in the

the human body digestion is performed by a simple attrition ; otherwise we may, with equal strength of reason, by as good arguments drawn from what is observed in fishes, prove that the aliments are dissolved in our stomachs by the action of a menstruum. But this method of reasoning is very faulty ; nor can it ever bring us to the true solution of any philosophical or medical problem. It is very plain, since the structure of the parts of the human stomach are so very different from that of this creature, that it is foolish and unreasonable to imagine both of them capable of producing the same effects. At each end of the stomach, there are as it were two particular sacs of a different texture from the rest of the stomach, not consisting of strong muscular fibres ; they seem to be receptacles for the stones, (especially at the end which is farthest from the orifice), while the digested aliment is protruded into the intestines.

The *duodenum* begins pretty near the same place at which the œsophagus enters : yet notwithstanding the vicinity of these two tubes, the aliments are in no danger of getting out before they are perfectly digested, by reason of a protuberance or *septum medium* betwixt the orifices ; and in those creatures who have such a strong muscular stomach, it is a matter of great indifference, whether the entry of the œsophagus or pylorus be highest, provided that the entry from the œsophagus does not allow the food to regurgitate, since the force of the stomach can easily protrude it towards the duodenum. This gut is mostly in the right-side, and hangs pendulous in their abdomen, having its two extremities fixed to the liver. The *ductus choledochus* enters near its termination, where it mounts up again to be fixed to the liver ; and lest, by the contraction of the intestines, the bile should pass over without being intimately blended with the chyle, that duct enters downwards, contrary to the course of the food, and contrary to what is observed in any of the animals we have yet mentioned. But still the general intention is kept in view, in allowing these juices the fairest chance of being intimately blended with the food.

The *small guts* are proportionally larger than those of carnivorous birds, for the general cause already assigned. At the end of the ilium they have two large *intestina cæca*, one on each side, which serve as reservoirs to the fæces ; which, after some remora, there regurgitate into
what

what soon becomes the rectum: which, together with the excretories of urine, and organs of generation, empties itself into the common cloaca. The small intestines are connected by a long loose mesentery, which has little or no fat accompanying the blood-vessels, there being no hazard of the blood's being stopped.

The *pancreas* in the creature lies betwixt the two folds of the duodenum, and sends two or three ducts into this gut pretty near the biliary.

The *spleen* is here of a round globular figure, situated between the liver and stomach, and betwixt these and the back-bone it enjoys the same properties as in other animals, *viz.* large blood-vessels, &c. All its blood is sent into the *vena portarum*, and has a perpetual conqussation. It has no excretory, as far as we know. Their *liver* is divided into two equal lobes by a pellucid membrane, running according to the length of their body; and hence we may observe, that it is not proper to that bowel to lie on the right side; which is still more confirmed by what we observe in fishes, where it almost lies in the left side.

The shape of their *gall-bladder* is not much different from that of quadrupeds; but is thought to be longer in proportion to the size of the animal, and is farther removed from the liver.

The principal difference to be remarked in their *heart*, is the want of the *valvule tricuspidæ*, and their place being supplied by one fleshy flap.

The *lungs* are not loose within the cavity of the thorax, but fixed to the bone all the way; neither are they divided into lobes, as in those animals that have a large motion in their spine. They are two red spongy bodies covered with a membrane that is pervious, and which communicates with the large vesicles or air-bags that are dispersed over their whole abdomen; which vesicles serve two very considerable uses. The one is to render their bodies specifically light, when they have a mind to ascend and buoy themselves up when flying, by distending their lungs with air, and also straiten their *trachea arteria* and so return the air. Secondly, they supply the place of a muscular *diaphragm* and strong abdominal muscles; producing the same effects on the several contained viscera, as these muscles would have done, without the inconveniency of their additional weight; and conducing as much to the exclusion of the egg and fæces.

The *trachea arteria*, near where it divides, is very much contracted; and their voice is principally owing to this coarctation. If you listen attentively to a cock crowing, you will be sensible that the noise does not proceed from the throat, but deeper; nay this very pipe, when taken out of the body and cut off a little after its division, and blown into, will make a squeaking noise, something like the voice of these creatures. On each side, a little higher than this contraction, there is a muscle arising from their sternum, which dilates the trachea. The cartilages, of which the pipe is composed in this animal, go quite round it; whereas in men and quadrupeds, they are discontinued for about one-fourth on the back part, and the intermediate space is filled up by a membrane. Neither is the trachea so firmly attached to their vertebræ as in the other creatures we have examined. This structure we shall find of great service to them, if we consider, that had the same structure obtained in them as in us, their breath would have been in hazard of being stopped at every flexion or twisting of their neck, which they are frequently obliged to. This we may be sensible of by bending our necks considerably on one side, upon which we shall find a great straitness and difficulty of breathing; whereas their trachea is better fitted for following the flexions of the neck by its loose connection to the vertebræ.

In place of a *muscular diaphragm* this creature has nothing but a thin membrane connected to the pericardium, which separates the thorax and abdomen. But besides this, the whole abdomen and thorax are divided by a longitudinal membrane or *mediastinum* connected to the lungs, pericardium, liver, stomach, and to the fat lying over their stomach and guts, which is analogous to an *omentum*, and supplies its place.

The *kidneys* lie in the hollow excavated in the side of the back-bone, from which there is sent out a bluish-coloured canal running along by the side of the *vàs deferens*, and terminating directly into the common cloaca. This is the *ureter*, which opens by a peculiar aperture of its own, and not at the penis. This creature having no *vesica urinaria*, it was thought by some they never passed any urine, but that it went to the nourishment of the feathers: but this is false; for that whitish substance that you see their greenish fæces covered with, and which turns afterwards chalky, is their urine.

urine. Let us next consider the organs of generation of both sexes, and first those of the male.

The *testicles* are situated one on each side of the back-bone; and are proportionally very large, to the creature's bulk. From these run out the *vasa seminifera*, at first straight; but after they recede farther from the body of the testicle, they acquire an undulated or convoluted form, as the epididymis in man. These convolutions partly supply the want of *vesiculæ seminales*, their coition being at the same time very short: These terminate in the penis, of which this creature has two, one on each side of the common cloaca pointing directly outwards; and are very small and short, whence they have escaped the notice of anatomists, who have often denied their existence. This is what is chiefly remarkable in the organs of the male.

The *racemus vitellorum*, being analogous to the ovaria in the human subject, are attached by a proper membrane to the back-bone. This is very fine and thin, and continued down to the uterus. Its orifice is averse with respect to the ovaria; yet notwithstanding, by the force of the *orgasmus venereus*, it turns round and grasps the *vitellus*, which in its passage thro' this duct, called the *infundibulum*, receives a thick gelatinous liquor, secreted by certain glands. This with what it receives in the uterus, compose the white of the egg. By this tube then it is carried into the uterus.

The *uterus* is a large bag, placed at the end of the *infundibulum*, full of wrinkles on its inside; here the egg is completed, receiving its last involution, and is at last pushed out at an opening on the side of the common cloaca. From the testes in the male being so very large in proportion to the body of the creature, there must necessarily be a great quantity of semen secreted; hence the animal is salacious, and becomes capable of impregnating many females. The want of the *vesiculæ seminales* is in some measure supplied by the convolutions of the *vasa deferentia*, and by the small distance betwixt the secreting and excretory organs. The two *penes* contribute also very much to their short coition, at which time the opening of the uterus into the cloaca is very much dilated, that the effect of the semen on the vitelli may be the greater.

A hen will of herself indeed lay eggs; but these are not impregnated, and yet appear entirely complete.

After having observed the contents of the abdomen and thorax, we next proceed to examine the parts about the neck and head.

These creatures, as was observed of fowls in general, have no teeth; which would have been needless, as they swallow their food entire: but their *tongue* is made pretty firm, lest it should be hurt by the sharp points of the grain they feed on. It is of a triangular figure, and pointed before; and as by their depending posture their meat is in hazard of falling out of their mouths, to prevent this there are several small pointed papillæ standing out upon their tongue and palate, with their points inclined backwards, allowing an easy passage to the food, but hindering its return.

We have here no *velum palatinum*, *uvula*, or *epiglottis*; and in place of two large holes opening into the nose, there is only a long narrow rima supplied with pretty strong muscles, and such another supplies the place of a glottis. The creature has a power of shutting both at pleasure; and the nature of their food seems not only to exempt them from the hazard of its getting into the nose or trachea, but its sharp points would hurt an uvula, or epiglottis, if they had any. Hence we see with what difficulty they swallow dough or other sort of food that can be easily moulded into any form.

Their *cranium* is more cellular and cavernous than ours. By this means their heads are light, yet strong enough to resist external injuries; for the enlarging the diameter of bones contributes to their strength. By this cavernous cranium the organ of smelling is supposed to be considerably enlarged; and further, singing birds, as is observed by Mr Ray and Mr Derham, have this cavernous structure of the brain still more observable: and we are told that the cavity of the tympanum communicates with the cells; but this I am apt to believe, so far as I could find from dissection, is rather founded on theory than matter of fact. Their brain is covered with the common membranes, but its external surface is not formed into so many gyræ or convolutions as ours. Its anterior part is quite solid, of a cineritious colour, and so far has a resemblance of the *corpora striata* as to give rise to the olfactory nerves. The whole of it appears to us as imperfect, and we can scarce determine whether there be any thing analogous to a third or fourth ventricle: neither the *corpus callosum*, *fornix*, *nates* or *testes*, &c. can be observed here; which parts therefore cannot be
imagined

imagined as absolutely necessary for the functions of life, since we find these creatures perform them sufficiently well. We may perhaps think these serve a particular use in man, who is a rational creature; but then quadrupeds enjoy them in common with man. These protuberances, &c. seem rather to depend on the different disposition of the several parts, being variously connected and meeting in different directions in different places, than their being absolutely necessary for any particular use; and the uses that have been assigned to different parts of the brain by authors, seem to me to have no foundation but in the author's fancy. I have already owned my ignorance of the uses of the particular parts of the brain, so shall not pretend to give reasons for their being different in different animals; but all seem to agree in this, that the cerebrum has always hollows and vacuities in it.

Their organ of *smelling* is very large, and well provided with nerves; hence they have this sensation very acute. Ravens and other birds of prey give a sure proof of this, by their being able to find out their prey though concealed from their sight and at a considerable distance.

Those birds that grope for their food in the waters, mud, &c. have large nerves which run quite to the end of their bills, by which they find out and distinguish their food.

The anterior part of their *eyes* (instead of having the sclerotic coat continued, *so as to make near a sphere as in us) turns all of a sudden flat; so that here the sclerotic makes but half a sphere; and the cornea rises up afterwards, being a portion of a very small and distinct sphere: so that in these creatures there is a much greater difference betwixt the sclerotic and cornea than in us. Hence their eyes do not jut out of their heads, as in man and quadrupeds. As most of these creatures are continually employed in hedges and thickets, therefore, that their eyes might be secured from these injuries, as well as from too much light when flying in the face of the sun, there is a very elegant mechanism in their eyes; which is a membrane rising from the internal canthus of the eye, which at pleasure, like a curtain, can be made to cover the whole eye; and this, by means of a proper muscle that rises from the sclerotic coat, and, passing round the optic nerves, runs through the *musculus oculi attollens* (by which however the optic nerves are not compressed), and palpebra, to be inserted into the edge of this membrane. Whenever this muscle

ceases to act, the membrane by its own elasticity again discovers the eye. This covering is neither pellucid nor opaque, both which would have been equally inconvenient; but being somewhat transparent, allows as many rays to enter as to make any object just visible, and is sufficient to direct them in their progression. By means of this membrane it is that the eagle is said to look at the sun. Quadrupeds also, as we mentioned before, have a small *membrana nictitans*.

Besides, all fowls have another particularity, the use of which I think is not so well understood; and that is, a pretty long black triangular purse, rising from the bottom of their eye just at the entry of the optic nerve, and stretched out into their vitreous humour, and one would imagine it gave some threads to the crystalline. This the French (who, as far as I know, were the first who took notice of it in their dissections before the Royal Academy) give the name of *bourse noire* to. This may possibly serve to suffocate some of the rays of light, that they may see objects more distinctly without hurting their eyes. It has a connection with the vitreous, and seems to be joined also to the crystalline humour. If we suppose it to have a power of contraction, (which may be as well allowed as that of the iris), it may so alter the position of the vitreous and crystalline humours, that the rays from any body may not fall perpendicularly upon the crystalline; and this seems to be necessary in them, since they cannot change the figure of the anterior part of their eye so much as we can do: and as this animal is exposed often to too great a number of rays of light, so they have no tapetum, but have the bottom of their eye wholly black on the retina; and in consequence of this, fowls see very ill in the dark.

They have no external ear; but in place thereof a tuft of very fine feathers covering the *meatus auditorius*, which easily allow the rays of sound to pass them, and likewise prevent dust or any insect from getting in. An external ear would have been inconvenient in their passing through thickets and in flying, &c. A liquor is separated in the external part of the ear, or *meatus auditorius*, to lubricate the passage, and further prevent the entrance of any insects, &c. The *membrana tympani* is convex externally; and no muscles are fixed to the bones of their ear, which are rather of a cartilaginous consistence: Any tremulous motions impressed on the

air

air are communicated in these creatures merely by the spring and elasticity of these bones; so probably the membrane is not so stretched as in the human ear by muscles. The semicircular canals are very distinct, and easily prepared.

The ANATOMY of a CARNIVOROUS BIRD.

WE come next to the birds of prey, and for an example shall take a *stenhil* or small hawk. The principal difference to be observed in them, is in their chylopoietic viscera, which may be accounted for from their different way of life.

Immediately under their clavicles, you will observe the œsophagus expanded into their *ingluvies*, which is proportionally less than in the granivorous kind, since their food does not swell so much by maceration; and for the same reason, there is a less quantity of a menstruum to be found here.

They have also a *ventriculus succenturiatus* plentifully stored with glands, situated immediately above their stomach, which we see here is thin and musculo-membranous, otherwise than in the granivorous kind: and this difference, which is almost the only one we shall find betwixt the two different species of fowls, is easily accounted for from the nature of their food, which requires less attrition, being easier of digestion than that of the other kind; nevertheless it seems requisite it should be stronger than the human, to compensate the want of abdominal muscles, which are here very thin.

The same mechanism obtains in this creature's *duodenum*, that we have hitherto observed. As being a carnivorous animal, its guts are proportionally shorter than those of the granivorous kind; for the reason first given, *viz.* its food being more liable to corrupt, therefore not proper to be long detained in the body; and for that reason it has no *intestina ceca*, of which the other species of fowls have a pair. The difference in their wings, backs, and claws, are obvious; and have been already in some measure observed.

There is a full description of the different parts of the egg, with the changes that happen in the time of incubation, in the second volume of the Medical Essays.

The ANATOMY of FISHES.

AQUEOUS animals are generally divided into such as have lungs, and such as want them. The first species differ very inconsiderably from an ox or any other quadruped, and are not easily procured; so that all I have to say on fishes shall be taken from that species which is not provided with respiratory organs.

Of these we may first observe, that they have a very strong thick *cuticle* covered with a great number of scales, laid one on another like the tiles of houses; this among other arguments is supposed to prove the human epidermis to be of a squamous structure: but the scales resemble the hairs, wool, feathers, &c. of the creatures that live in air; and below these we observe their proper *cuticula* and *cutis*.

In the next place, these creatures have neither anterior nor posterior extremities, as quadrupeds and fowls; for their progression is performed in a different way from either of these species of animals: for this purpose they are provided with machines, properly consisting of a great number of elastic beams, connected to one another by firm membranes, and with a tail of the same texture; their spine is very moveable towards the posterior part, and the strongest muscles of their bodies are inserted there. Their tails are so framed as to contract to a narrow space when drawn together to either side, and to expand again when drawn to a straight line with their bodies; so, by the assistance of this broad tail, and the fins on their sides, they make their progression much in the same way as a boat with oars on its sides and rudder at its stern. The perpendicular fins situated on the superior part of their body keep them *in æquilibrio*, hindering the belly from turning uppermost: which it would readily do, because of the air-bag in the abdomen rendering their belly specifically lighter than their back; but by the resistance these fins meet with when inclined to either side, they are kept with their backs always uppermost.

The best account of this matter we have in the treatise before-mentioned, viz. *Borelli de Motu Animalium*, cap. 23.

It may be next observed, that these creatures have nothing that can be called a *neck*, seeing they seek their food in an horizontal way, and can
move

move their bodies either upwards or downwards as they have occasion by the contraction or dilatation of their air-bag : a long neck, as it would hinder their progression, would be very disadvantageous in the element they live in.

The *abdomen* is covered on the inferior part with a black-coloured thin membrane resembling our peritoneum. It is divided from the thorax by a thin membranous partition which has no muscular appearance ; so that we have now seen two different sorts of animals that have no muscular diaphragm.

These creatures are not provided with *teeth* proper for breaking their aliment into smaller morsels, as the food they use is generally small fishes or other animals that need no trituration in the mouth, but spontaneously and gradually dissolve into a liquid chyle. Their teeth serve to grasp their prey, and hinder the creatures they have once caught from escaping again. For the same purpose, the internal cartilaginous basis of the bronchi, and the two round bodies situated in the posterior part of the jaws, have a great number of tender-hooks fixed into them, in such a manner, as that any thing can easily get down, but is hindered from getting backwards. The water that is necessarily taken in along with their food in too great quantities to be received into their jaws in deglutition, passes betwixt the interstices of the bronchi and the flap that covers them. The compression of the water on the bronchi is of considerable use to the creature, as we shall explain by and by.

The *œsophagus* in these creatures is very short, and scarcely distinguished from their stomach, seeing their food lies almost equally in both. The stomach is of an oblong figure. There are commonly found small fishes in the stomach of large ones still retaining their natural form ; but when touched, they melt down into a jelly. From this, and the great quantity of liquors poured into their stomachs, we may conclude, that digestion is solely brought about in them by the dissolving power of a menstruum, and that no trituration happens here.

The *guts* in these animals are very short, making only three turns ; the last of which ends in the common cloaca for the fæces, urine, and semen, situated about the middle of the inferior part of their bodies.

What I call *pancreas*, some give the name of *intestinula cæca* to : it consists

sists of a very great number of small threads, like so many little worms, which all terminate at last in two larger canals, that open into the first gut, and pour into it a viscous liquor, much about the place where the biliary ducts enter. Their intestines are connected to the back-bone by a membrane analogous to a mesentery. No lacteals have been yet observed.

Their *liver* is very large, of a whitish colour, and lies almost in the left-side wholly, and contains a great deal of fat.

The *gall-bladder* is situated a considerable way from their liver; and sends out a canal, the cystic duct, which joins with the hepatic duct just at the entry into the gut. Some fibres are stretched from the liver to the gall-bladder, but none that I know of have hitherto discovered any cavity in these cords: so in this animal it should seem impossible that the bile can be carried into the gall-bladder in the ordinary way; and consequently must either be secreted on the sides of that sac, or regurgitate into it from the canalis choledochus.

The *spleen* is placed near the back-bone, and at a place where it is subjected to an alternate pressure from the constriction and dilatation of the air-bag, which is situated in the neighbourhood. Since in all the different animals we have dissected we find the spleen attached to somewhat that may give it a compression, as in the human subject and quadrupeds it is contiguous to the diaphragm; in fowls, it is placed betwixt the back-bone, the liver, and stomach; in fishes, it lies on the sacculus aërius: and since we find it so well served with blood-vessels, and all its blood returning into the liver; we must not conclude the spleen to be an *inutile pondus*, only to serve as a balance to the animal *pro æquilibrio*, but particularly designed for preparing the blood to the liver.

The only *organs of generation* in this animal are two bags situated in the abdomen uniting near the podex. These in the male are filled with a whitish firm substance called the *milt*; and in the female with an infinite number of little ova clustered together, of a reddish yellow colour, called the *roe*. Both these at spawning-time we find very much distended; whereas at another time the male organs can scarce be distinguished from the female; nor is there any proper instrument in the male for throwing the seed into the organs of the female as in other creatures. I shall

shall not take upon me to determine the way whereby the female sperm is impregnated; but we find that the spawn of frogs consists in the small specks wrapped up in a whitish glutinous liquor; these specks are the rudiments of the young frogs, which are nourished in that liquor till they are able to go in search of their food. In the same way, the ova of fishes are thrown out and deposited in the sand, the male being for the most part ready to impregnate them, and they are incubated by the heat of the sun. It is curious enough to remark with what care they seek for a proper place to deposit their ova, by swimming to the shallow, where they can better enjoy the sun's rays, and shun the large jaws of other fishes. The river-fishes, again, spawn in some creek free from the hazard of the impetuous stream. But whether this mixture be brought about in fishes by a simple application of the genitals to each other, or if both of them throw out their liquors at the same time in one place, and thus bring about the desired mixture, it is not easy to determine; the latter, I think, seems most probable. These creatures are so shy, that we cannot easily get to observe their way of copulation; and are consequently but little acquainted with their natural history.

After raising up the black peritoneum, there comes in view an oblong white membranous bag, in which there is nothing contained but air. This is the *swimming-bladder*: it lies close to the back-bone, and has a pretty strong muscular coat, whereby it can contract itself. By contracting this bag, they can make the muscles specifically heavier than water, and so readily fall to the bottom; whereas the muscular fibres ceasing to act, they become specifically lighter than water, and so swim above. According to the different degrees of contraction and dilatation of this bladder, they can keep higher or lower in the water at pleasure. Hence flounders, soles, raia, and such other fishes as want this sac, are found always groveling at the bottom of the water: it is owing to this that dead fishes (unless this membrane has been previously broke) are found swimming a-top, the muscular fibres then ceasing to act, and that with their bellies uppermost; for the back-bone cannot yield, and the distended sac is protruded into the abdomen, and the back is consequently heaviest at its upper part, according to their posture. There is here placed a glandular substance, containing a good quantity of red blood. From the an-

terior part of the bag go out two *processes* or *appendices*, which, according to the gentlemen of the French academy, terminate in their fauces: but in some fishes, as the cod and haddock, I never could find out this communication, either by tracing them, pouring in mercury or water, &c. I put, it is true, a probe through them; but then with the same strength I could have put it through the sides of the processes.

At the superior part of this bag there are other red-coloured bodies of a glandular nature, which are connected with the kidneys. From them the *ureters* go down to their insertion in the *vesica urinaria*, which lies in the lower part of the abdomen, and the urethra is there produced which terminates in the podex.

These last mentioned parts have not hitherto been observed in some species of fishes; whence authors too hastily denied them in all. These creatures have a *membranous diaphragm* which forms a sac, in which the heart is contained. It is very tense, and almost perpendicular to the vertebræ.

The *heart* is of a triangular form, with its base downwards, and its apex uppermost; which situation it has because of the *branchiæ*. It has but one *auricle* and one *ventricle*, because they want lungs, and one great artery. The size of the auricle and that of the ventricle are much the same; the artery sends out numberless branches to the *branchiæ* or gills.

The *branchiæ* lie in two large flits at each side of their heads, and seem to be all they have that bears any analogy to lungs. Their form is semicircular; they have a vast number of red fibrillæ standing out on each side of them like a fringe, and very much resemble the vane of a feather. These *branchiæ* are perpetually subjected to an alternate motion and pressure from the water; and we may here remark, that we have not found any red blood but in places subjected to this alternate pressure. This observation will help us in explaining the action of the lungs upon the blood. Over these gills there is a large flap, allowing a communication externally by which the water they are obliged to take into their mouths with their food finds an exit without passing into their stomach: it is owing to these flaps coming so far down that the heart is said commonly to be situated in their heads.

Their *brains* are formed pretty much in the same way as that of fowls; only

only we may observe, that the posterior lobes bear a greater proportion to the anterior.

Their organ of *smelling* is large; and they have a power of contracting and dilating the entry into their nose as they have occasion. It seems to be mostly by their acute smell that they discover their food: for their tongue seems not to have been designed for a very nice sensation, being of a pretty firm cartilaginous substance; and common experiment evinces, that their sight is not of so much use to them as their smell in searching for their nourishment. If you throw a fresh worm into the water, a fish shall distinguish it at a considerable distance; and that this is not done by the eye, is plain from observing, that after the same worm has been a considerable time in the water and lost its smell, no fishes will come near it: but if you take out the bait, and make several little incisions into it, so as to let out more of the odoriferous effluvia, it shall have the same effect as formerly. Now it is certain, had the creatures discovered this bait with their eyes, they would have come equally to it in both cases. In consequence of their smell being the principal means they have of discovering their food, we may frequently observe their allowing themselves to be carried down with the stream that they may ascend again leisurely against the current of the water; thus the odorous particles swimming in that medium, being applied more forcibly to their smelling organs, produce a stronger sensation.

The *optic nerves* in these animals are not confounded with one another in their middle progress betwixt their origin and the orbit, but the one passes over the other without any communication; so that the nerve that comes from the left side of the brain goes distinctly to the right eye, and *vice versa*.

The *lens crystallina* is here a complete sphere, and more dense than in terrestrial animals, that the rays of light coming from water might be sufficiently refracted.

As fishes are continually exposed to injuries in the uncertain element they live in, and as they are in perpetual danger of becoming a prey to the larger ones, it was necessary their eyes should never be shut; and as the cornea is sufficiently washed by the element they live in, they are not provided with palpebræ: but then, as in the current itself the eye must

be exposed to several injuries, there was a necessity it should be sufficiently defended; which in effect it is by a firm pellucid membrane, that seems to be a continuation of the cuticula, being stretched over here. The epidermis is very proper for this purpose, as being insensible and destitute of vessels, and consequently not liable to obstructions or by that means of becoming opaque.

Whether fishes have a sense of *hearing* or not, is very uncertain: all that have the appearance of an organ of hearing in these creatures, are two bones, or rather stones, each about the bulk of a small horse-bean; of a particular structure, being very brittle, and composed of a great many different segments laid at one another's sides, and situated in particular sacs at each side of the brain. Is then the idea of sound communicated to them by means of these stones? Or does their running away, at stamping hard on the ground, or crying loud, depend upon some other kind of sensation? This may possibly be produced in them, by a tremulous motion communicated to their bodies by the circumambient water, which is put in agitation from the like concussions happening in the air or neighbouring ground.

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